CLINICAL AND HISTOLOGICAL EVALUATION OF EXTRACTION SOCKET PRESERVATION USING BIO-OSS®COLLAGEN- A 6 MONTHS STUDY

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THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

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BRANCH II

PERIODONTICS

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CERTIFICATE

This is to certify that this dissertation titled **CLINICAL AND HISTOLOGICAL EVALUATION OF EXTRACTION SOCKET PRESERVATION USING BIO-OSS®COLLAGEN- 6 MONTH STUDY** is a bonafide record of work done by **Dr APARNNA SURESH** during her postgraduate study period 2008-2011.

This dissertation is submitted to the TAMILNADU DR.M.G.R MEDICAL UNIVERSITY in partial fulfillment for the degree of **MASTER OF DENTAL SURGERY, BRANCH – II PERIODONTICS.** It has not been submitted (partial or full) for any other degree or diploma.

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LIST OF ABBREVIATIONS

1.	ABB	Anorganic Bovine Bone mineral
2.	ACS	Absorbable Collagen Sponge
3.	ADMA	Acellular Dermal Matrix Allograft
4.	CAL	Clinical Attachment Level
5.	CEJ	Cemento Enamel Junction
6.	CESE	Conventional Extraction Socket Evaluation
7.	DFDBA	Demineralized Freeze Dried Bone Allograft
8.	DBBM	Deproteinised Bovine Bone Mineral
9.	DMB	Demineralised Bone
10.	ePTFE	Expanded Polytetrafluoroethylene
11.	GBR	Guided Bone Regeneration
12.	HA	Hydroxyapatite
13.	IOPA	Intra Oral Periapical Radiograph
14.	PBBM	Porous Bovine Bone Mineral
15.	PD	Probing Depth
16.	RVG	Radiovisuography
17.	RRR	Residual Ridge Resorption
18.	rhBMP-2	recombinant human Bone Morphogenetic Protein-2
19.	SIE	Support Immersion Endoscope
20.	TCP	Tri Calcium phosphate

ABSTRACT

Background:

Socket preservation at the time of extraction is done in an attempt to reduce crestal bone loss, encourage more socket fill, minimize horizontal ridge resorption and ultimately reduce or eliminate the need for further ridge augmentation The present study was to evaluate clinically and histologically the soft and hard tissues parameters following placement of *bone replacement graft* **(Bio-Oss® Collagen)** in extraction sockets

Materials and methods:

Ten patients selected from the Outpatient Department of Periodontics, Ragas Dental College & Hospital, Chennai, were included in this clinical trial for socket preservation using block xenograft. All these patients were assessed clinically and radiographically prior to the surgical procedure. The clinical parameters assessed were width of keratinised gingiva, distance between tip of papilla to CEJ of adjacent teeth, distance between CEJ of adjacent teeth and gingival margin, gingival thickness, buccolingual crest width 2m from the crest and 4mm from the crest, vertical plate labial position and the number of existing walls of the extraction socket at baseline,3 months and 6 months follow up. Histological analysis of the augmented site was done during the surgical re-entry for implant placement after 6 months. Statistical analysis was done using the Wilcoxon Signed-Rank Sum Test.

Results:

At the end of 3 months, there was significant decrease in the width of keratinized gingiva (from 4.00mm ±0.54 to 2.88mm± 0.35). There was significant average decrease in the horizontal width at 2mm , which was more evident in the midbuccal region (from 7.75mm±1.28 to 6.25mm ± 1.39).However no significant difference was observed in the horizontal width values at 4mm from the crest. Histological analysis revealed new bone formation along with minimal residual graft material; confirming the osteoconductive property of the bone substitute.

Conclusion:

This study proved the regenerative potential of cancellous –bone block placed in extraction sockets; and also its role in maintaining favourable alveolar bone topography for implant placement .Bio-Oss® Collagen seems to have the potential to limit but not avoid completely the postoperative contour shrinkage.

Key words:

Extraction socket, socket preservation, bone substitutes, bone regeneration, endosseous implants.

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INTRODUCTION

Tooth replacement with dental implants has proven to be a reliable and effective means of restoring the lost dentition. The use of implants for single tooth replacement can conserve sound tooth structure by reducing the need to prepare adjacent teeth as abutments. This can also simplify the restoration of esthetically difficult areas such as those with diastema and irregular tooth position.

The advent of osseointegration, and advances in biomaterials and techniques and newer equipments have contributed to increased application of dental implants in restoring partial and complete edentulous patients.[2,52]

The most significant local factors for successful implant placement are the quality and quantity of bone present at the implant site. Factors that are necessary for clinical and successful osseointegrated implants are adequate bone density, ridge height and width; and a minimum of atleast 2mm of bone surrounding the implant.[35]

Bone loss occurs on a predictable basis following loss of the natural dentition, provided no interceptive therapies are carried out.

The bone surrounding the tooth is often prone to disease/infection resulting in alveolar bone deformity following tooth extraction. It has been

studied that an average of 2-2.5mm of horizontal bone resorption and 1mm of vertical bone resorption occurs following tooth extraction.[84] This type of bone resorption often takes place in the first 2-6months following tooth removal. These deformities can create major problems while performing restorative dentistry, irrespective of whether the treatment plan involves dental implants, fixed/removable prostheses.

Many researchers believe that these deformities can be minimised by placing an implant at the time of tooth extraction.[7,12]. But the surgical placement of implant in fresh extraction sites failed to prevent the remodelling that occurred in the walls of the socket.[33] The level of bone support and the soft tissue dimensions surrounding the implant-supported restoration are the two most important factors that influence esthetic outcomes.[22] Labial plate position, its thickness and buccal bone loss are equally important considerations for esthetic implantation and in many cases, they may necessitate hard tissue augmentation. [85,56]

Socket preservation at the time of extraction is done in an attempt to reduce crestal bone loss, encourage more socket fill, minimize horizontal ridge resorption and ultimately reduce or eliminate the need for further ridge augmentation. Several studies have proposed various ridge preservation techniques following tooth extractions, including the placement of graft materials and/or the use of occlusive membranes with success rates of implants in regenerated bone comparable to the success rates of implants

placed in native bone.[69,27] Ridge dimensions become a critical evaluation criteria following these techniques.

The use of terms like ridge preservation and socket preservation is not consistent in the literature. Therefore at First German Expert Meeting On Socket Preservation, Mohrfelden, Germany, January 2007 the term socket preservation was proposed for the treatment of fresh extraction sockets with intact buccal bone walls . In contrast ridge preservation was deemed appropriate for situations involving deficient buccal bone walls. The rationale behind this terminology is that the presence of the buccal bone wall is believed to have a relevant influence on bone healing and these terms reflect the difference between the situations.

Biomaterials/ biological agents such as autogenous bone , bioactive glass, coralline calcium carbonate, decalcified freeze dried bone, deproteinized bovine bone, hydroxyapatite etc. are frequently used to augment compromised regions of the ridge and to make the edentulous site available for successful implant installation[21] .It was demonstrated that several biomaterials were i) incorporated in newly formed bone tissue, ii) maintained as inactive fillers and iii) resorbed when the host tissue was undergoing remodelling [5]

The aim of this study is to clinically and histologically evaluate the soft and hard tissues parameters following placement of *bone replacement graft* **(Bio-Oss ®Collagen)** in extraction sockets, prior to implant placement.

INTRODUCTION

Tooth replacement with dental implants has proven to be a reliable and effective means of restoring the lost dentition. The use of implants for single tooth replacement can conserve sound tooth structure by reducing the need to prepare adjacent teeth as abutments. This can also simplify the restoration of esthetically difficult areas such as those with diastema and irregular tooth position.

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REVIEW OF LITERATURE

Bartee Bk (**2001**)[18] in a review article, alveolar ridge resorption has long been considered an unavoidable consequence of tooth extraction. While the extent and pattern of resorption is variable among individuals, there is a progressive loss of ridge contour as a result of physiologic bone remodelling. Over the long term, prosthodontic complication, loss of function, and inadequate bone for the placement of dental implants may result.

The long-term osseointegration of dental implants also relies on placement within bone that has adequate trabecular density, ridge height and width [62] A ridge that is too narrow i.e. less than 5mm will be unable to accommodate standard 3.75mm diameter implants.

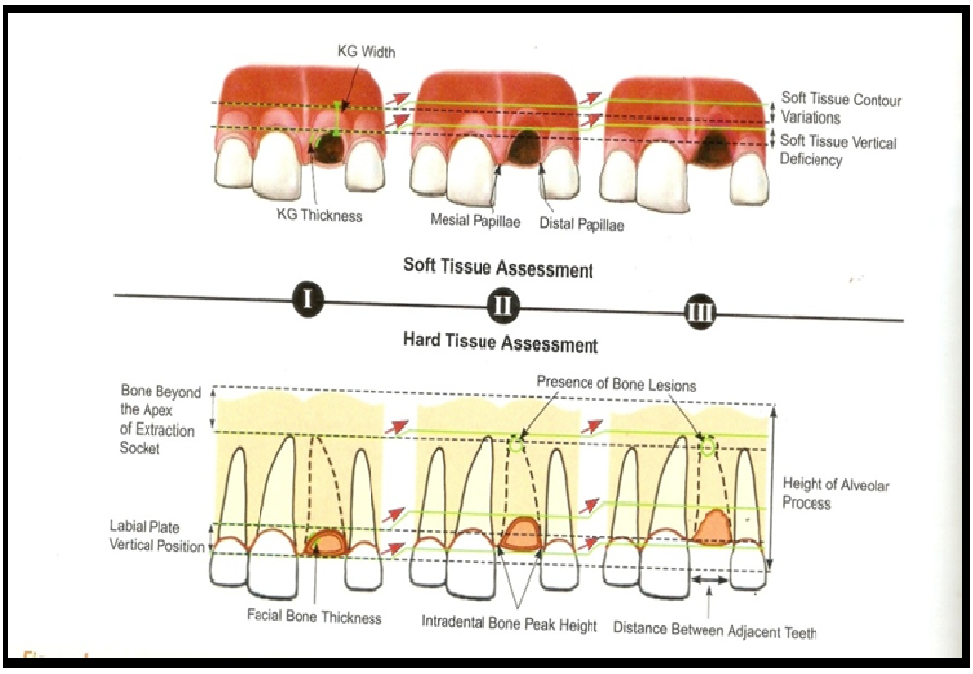
Guided bone regeneration techniques and the use of bone replacement materials have both been shown to enhance socket healing and modify the resorption process.

Classification of extraction sockets

Gintaras Juodzbalys et al (2008) [55] proposed a new classification system for the anterior maxillary extraction sockets based upon soft and hard tissue components.

Extraction Socket Soft and Hard Tissue Assessments and Extraction Socket Types

Assessment	Extraction Socket Types		
	Adequate	Compromised	Deficient
Soft tissue			
Quantity			
Soft tissue contour variations	No	<2 mm	≥2 mm
Soft tissue vertical deficiency	No	1 to 2 mm	>2 mm
KG width (mm)	>2	1 to 2	<1
Mesial and distal papillae appearance (Nordland and Tarnow[34])	I	II	III
Quality			
Soft tissue color, consistency, and contour	Pink, firm, and smooth	Slightly red and a soft, spongy, and uneven contour	Red/bluish or red with a soft edematous and boggy or craterlike appearance
Biotype			
Biotype of gingival tissue (mm)	Thick (≥2.0)	Moderate (≥1.0 to <2.0)	Thin (<1.0)
Hard tissue			
Height of alveolar process (mm)	>10	>8 to ≤10	≤8
Available bone beyond the apex of extraction socket (mm)	≥4	≥3 to <4	<3
Extraction socket labial plate vertical position (mm)	≤3	>3 to <7	≥7
Extraction socket facial bone thickness (mm)	≥2	≥1 to <2	<1
Presence of socket bone lesions	No	Yes	Yes
Mesial and distal intradental bone peak height (mm)	3 to 4	≥1 to <3	<1
Mesio-distal distance between adjacent teeth (mm)	≥7	>5 to <7	≤5
Need for palatal angulation	<5°	5° to 30°	>30°



Extraction socket soft and hard tissue assessment and extraction socket types I,II,III= assessment scores.

The classification is derived from soft and hard tissue variables

1. Soft tissue contour variations: vertical distance between the socket and the adjacent teeth's buccal gingival scallop margin.
2. Vertical soft tissue deficiency: vertical distance between the socket and adjacent teeth's buccal mucosa tissue margins.
3. Keratinised gingival width.
4. Mesial and distal papillae appearance using classification described by Norland and Tarnow.
5. Gingival tissue biotype.
6. Soft tissue quality.
7. The height of the alveolar process: distance between the tip of the extraction socket labial plate and nasal sinus floor.
8. Available bone beyond the apex of extraction socket: distance between the socket apex and the nasal sinus floor
9. Extraction socket labial plate vertical position: distance between the tip of the extraction socket labial plate and the CEJ of adjacent teeth.
10. Extraction socket facial bone thickness
11. Presence of socket bone lesions

12. Mesial and distal intradental bone peak height: distance from the tip of the interdental bone peak to the alveolar crest midline.

13. Mesio-distal distance between adjacent teeth: distance measured in the M-D between two adjacent teeth's CEJ.

14. Palatal angulation: angle between the extraction socket and the neighbouring teeth.

Extraction socket assessment

Gintaras Juodzbalys et al (**2008)** [54] conducted the study to determine the indications, efficacy and advantages of the support immersion endoscope (SIE) method for extraction socket assessment. Conventional extraction socket evaluation (CESE) includes: visual evaluation, periodontal probing, ridge mapping with callipers, dental mirror, orthopentamogram and diagnostic wax up. The results of the study was that CESE+SIE had significantly better accuracy in examining extraction socket labial plate vertical position, labial plate thickness and bone quality compared to CESE alone.

Healing of extraction socket

The alveolar process is a tooth-dependent tissue that is developed in conjuction with tooth eruption. The topography is determined by the form of the teeth and the axis of eruption. Subsequent to tooth extraction, the alveolar

ridge undergoes resorption and atrophy, thus exhibiting a wide range of dimensional changes among individual patients.

Rodgers et al (1941)[77] Tooth extraction, result in resorption of the alveolar bone housing that results in changes of the alveolar bone morphology. These changes do not always follow a consistent pattern, frequently resulting in excessive loss of both height and width of bone

Sobolik et al (1960) [84] reported that the normal post- extraction healing response of an intact alveolar socket is resorptive. The greatest amount of bone loss is in the horizontal dimension and occurs on the facial aspect of the ridge.

Lam et al (**1960)**[57] in a clinical human study assessed 20 patients who underwent extraction of maxillary anterior teeth and he observed that the maximum loss of soft tissue took place during the first month (approximately 70-90%) and 1 year post operatively the loss in labial thickness was in the range of 3.0-5.6mm. They demonstrated that changes in the edentulous anterior maxillary ridge dimension can change dramatically in height and width. The residual ridge shifts palatally in the maxilla and lingually in the mandible in relation to tooth position at the expense of the buccal cortical plate in all areas of the jaws, regardless of the number of teeth missing

Pietrokovski et al (1967)[75] demonstrated that in the anterior maxilla, where the buccal plate often is extremely thin and friable, consistent bone resorption is found after extraction

Atwood et al (1971)[16] has described residual ridge resorption (RRR) as morphologic changes of the alveolar process following tooth extraction. He studied the bone loss patterns of edentulous alveolar ridges and suggested various etiologic factors that cause Residual Ridge Resorption (RRR) and categorized the factors in four major groups as follows: anatomic, prosthetic, metabolic and functional.

Cardaropoli G et al (2003)[30] studied in dogs the events involved in the healing of marginal, central and apical compartments of an extraction socket. Series of events included the formation of a coagulum that was replaced by i) a provisional connective tissue matrix ii) woven bone and iii) lamellar bone and bone marrow. During the healing process a hard tissue bridge- cortical bone- formed, which 'closed' the socket.

Araujo MG and Lindhe J (2005)[7] studied the dimensional changes following tooth extraction in dogs, as well as processes of bone modelling and remodelling associated with such change. They concluded that the resorption of the buccal/lingual walls of the extraction site occurred in two overlapping phases. During phase I, the bundle bone was resorbed and replaced with woven bone. Since the crest of the buccal bone wall was comprised solely of

bundle this modelling resulted in substantial vertical reduction of the buccal crest. Phase 2 included resorption that occurred from the outer surfaces of both bone walls.

Huebsch etal 1969[48] in a histopathologic study of extraction wounds in dogs demonstrated that the healing process in disturbed and undisturbed extraction sockets is essentially parallel, except that in the disturbed sockets there is delayed healing. In undisturbed sockets, new bone is laid down directly on the alveolar bone lining the socket and the sockets completely regenerate in 21 to 28 days. In later stages of healing, the undisturbed sockets are well filled with bone. The central part of the disturbed sockets, on the other hand, is filled with edematous connective tissue, bone spicules, etc., which discourage healing with healthy fibrous connective tissue and bone.

Immediate Implant placement

The immediate placement of implant in conjunction with bone augmentation has shown comparable success to that observed in delayed implant placement.

Sclar A G (2004)[80] showed that in the anterior maxilla, grafting for space maintenance and ridge preservation may be beneficial.

Immediate post extraction implant placement should be considered only if the implant stability can be achieved; otherwise a staged approach is used.

Block M S and Kent.J N (1991)[24] reported a 4-year experience with placement of hydroxylapatite coated dental implants into extraction sites immediately after tooth extraction. Small defects present after implant placement were treated with dense, nonresorbable *hydroxylapatite.* Larger defects present after implant placement were treated with *demineralized or chemosterilized autolyzed antigen-extracted allogeneic bone*. Hydroxylapatite particles were chosen when sufficient bone was available to interface and stabilize the implant, and DMB was chosen when the defect around the implant was greater than approximately 4 mm and could possibly compromise the amount of bone interface available for stabilization of the implant.

Rosenquist B et al (1996)[78] evaluated the degree of bone fill and the extent of implant thread exposure of immediate implants placed into the extraction sockets. They also demonstrated that healing with immediate implants is similar to extraction socket alone; however the vascularity is compromised for the overlying soft tissue with the implant in place, resulting in potentially more soft tissue healing complications.

Histological and histomorphometric analyses of human biopsies by **Wilson et al (1998)**[90] on implants placed in immediate extraction sites reported that the degree of bone-implant integration is highly dependent on the gap present between the inner aspect of the socket and implant surface.

To preserve the extraction socket architecture and to accelerate the timeline to final implant placement, extraction socket augmentation often is proposed.

Extraction socket augmentation using bone replacement grafts

To minimise bone resorption, less traumatic extraction techniques with socket augmentation, using a variety of particulate bone graft materials with and without membrane barriers were reported. These preservation techniques demonstrated significantly reduced alveolar ridge dimensional changes.

Becker et al (1994)[19] tested the bone-forming capacity of demineralized freeze-dried bone (DFDBA) and autologous bone grafts in extraction sockets. DFDBA sites revealed the presence of dead particles of DFDBA with no evidence of bone formation on the surfaces of the implanted particles and no evidence of osteoclastic resorption of the bone particles. The results of this study questioned the use of DFDBA as a bone inductive graft material.

Nemcovsky CE and SerfatyV ((**1996)**[66] preserved the alveolar ridge after extracting maxillary anterior teeth with advanced bone loss using non-resorbable hydroxyapatite crystals as graft material and a rotated pediculated split thickness palatal flap to cover them. Most of the ridge reduction was recorded during the first postoperative month. Ridge dimensions decreased vertically within a range of 1 mm to 2 mm (mean of 1.4 mm) and in the buccal aspect from 0 mm to 2 mm (mean of 0.6 mm).

Brugnami et al (**1996)**[26] evaluated new bone formation in human extraction sockets treated with demineralized freeze-dried bone allografts (DFDBA) and cell occlusive membranes. Histologic analysis revealed that all particles of DFDBA were well incorporated within new bone, which exhibited osteocyte-containing lacunae. Distinct cement lines clearly demarcated the DFDBA particles from the surrounding, intimately-apposed woven and lamellar bone.

Lekovic et al (1997)[60] in a case report on Bone Regenerative Approach to Alveolar Ridge Maintenance Following Tooth Extraction, one socket was covered with an expanded polytetrafluoroethylene (ePTFE) barrier membrane (experimental site); the other socket was a conventional control. Clinical and model measurements have shown statistically significant better ridge dimensions at experimental sites than at control.

Artzi and Nemcovsky (1998)[15] used a deproteinized bovine bone mineral (DBBM) as a socket site filler material to maintain ridge configuration, without applying an occlusive membrane. New bone formation was observed in all histological specimens.

Lekovic et al (1998)[59] evaluated the clinical effectiveness of a bioabsorbable membrane made of glycolide and lactide polymers (ePTFE membranes) in preserving alveolar ridges following tooth extraction using a surgical technique based on the principles of guided bone regeneration. Reentry surgeries were performed at 6 months. Results showed that experimental sites presented with significantly less loss of alveolar bone height, more internal socket bone fill, and less horizontal resorption of the alveolar bone ridge.

Becker et al (1998)[20] compare extraction socket healing after implantation with either xenogenic bovine bone, demineralized freeze-dried bone (DFDBA), autologous bone or human bone morphogenetic proteins in an osteocalcein/osteonectin carrier *(hBMP/NCP)* . Intraoral autologous bone, xenogenic bone, and DFDBA appear to interfere with normal extraction socket healing.

Gothier et al (1999)[45] evaluated the osteoconductive properties of an injectable bone substitute composed of a polymeric carrier and a biphasic calcium phosphate (BCP) ceramic, used to fill canine extraction sockets.

Qualitative histological studies showed that the substitute was able to support the extensive apposition of well mineralised newly formed lamellar bone over the entire socket surface and appeared to prevent alveolar ridge resorption compared to unfilled control sites.

Camargo et al (2000)[28] evaluated the clinical effectiveness of bioactive glass *(Biogran, Orthovita)* used as a graft material combined with calcium sulfate *(Capset,Lifecore)* used in the form of a mechanical barrier in preserving alveolar ridges after tooth extraction. Control sites did not receive any graft or calcium sulfate. Titanium pins served as fixed reference points for measurements. Reentry surgeries showed that experimental sites presented with (1) significantly more internal socket bone fill (6.43 ±2.78 mm vs 4.00 ± 2.33 mm on control sites), (2) less resorption of alveolar bone height (0.38 ± 3.18 mm vs 1.00 ± 2.25 mm on control sites), and (3) similar degree of horizontal resorption of the alveolar bony ridge as compared with controls (3.48 ± 2.68 mm vs 3.06 ± 2.41 mm on control sites).

Fowler et al (**2000)**[40] utilized acellular dermal allograft *(Alloderm)* and demineralized freeze-dried bone (DFDBA) for ridge preservation following tooth extraction. The report demonstrated esthetic results with no loss of ridge height and width. Soft tissue dimensions were also preserved.

Artzi et al (**2000**)[13] investigated the influence of Porous bovine bone mineral *(Bio-Oss®,Geistlich)* on the histopathological pattern of the intrasocket regenerated bone and evaluated histomorphometrically the healed PBBM grafted extraction socket 9 months postoperatively. Bone fill of augmented sites were 82.3%. histomorphoetric measurements showed an increase of mean bone tissue along the histological section from 15.9% in the coronal part to 63.9% apically.

Artzi et al (**2001**)[14] investigated histochemically tissue sockets grafted with Porous bovine bone mineral *(Bio-Oss®, Geistlich)* to reveal that newly formed bone encircled and adhered to the grafted material in most specimens. An average of 17.1% osseous tissue with 1:12.9 lamellar/woven ratio was calculated in the superficial areas, whereas 63.9% osseous tissue, with a lamellar/ woven ratio of 1:1.7 was observes in deep areas of the specimen tissues

Froum et al (**2002**)[42] investigated the effect of Bioactiveglass *(Biogran)* and DFDBA *(University of Miami Bone Bank)* on extraction socket healing. Results concluded that mean vital bone present was 59.5% for bioactive glass, 34.7% for DFDBA and 32.4 % for unfilled socket control, not statistically significant. The residual graft material was significantly higher in DFDBA-treated (13.5%) versus bioactive glass treated sockets (5.5%).

Indovina A Jr , Block MS (2002)[51] evaluated the healing response of 3 bone substitutes in canine extraction sites. No significant difference as noted in shape of the ridges between groups. The untreated control and the BioOss *(Osteohealth)* were similar with bone filling most of the extraction sites. *Bone Source* and *Embarc* sites were filled predominantly with graft material without the evidence of resorption and replacement of the materials, and with minimal bone formation.

Iasella et al (**2003)**[50] ridge preservation with freeze dried bone allograft *(American Red Cross)* and a collagen membrane *(Biomend Extend)* compared to extraction alone for implant site development. Both the ridge preserved and extraction alone sites lost width although an improved result was found in the RP group. Histological analysis revealed more bone formation in RP group

Zubillaga et al (**2003)**[94] designed a study to determine if the amount of GBR would be affected by using a osteoinductive DFDBA *(Regenafil)* and bioabsorbable membrane *(Resolut XT)* and membrane stabilisation. Results indicated a complete loss of augmented width 3mm from the crest and almost complete loss in height and width 5mm form the crest. Membrane stabilization appeared to be beneficial .

Serino G et al (2003)[81] evaluated whether alveolar ridge resorption following tooth extraction could be prevented or reduced by the application of

a bioabsorbable *polylactide-polyglycolide sponge* used as a space filler, compared to natural healing by clot formation. The clinical measurements at 6 months revealed, in the mesial-buccal site, a loss of bone height of 0.2 mm in the test and 0.6 mm in the controls; in the mid-buccal portion a gain of 1.3 mm in the test and a loss of 0.8 mm in the controls; and in the distal portion a loss of 0.1 mm in the test and of 0.8 mm in the controls. The biopsies harvested from the test sites revealed that the new bone formed at 6 months was mineralized, mature and well structured. Particles of the grafted material could not be identified in any of the 10 test biopsies.

Froum et al (2004)[43] investigated the effect on extraction socket healing when an absorbable hydroxyapatite (AH) and a nonabsorbable anorganic bovine bone mineral (ABB) covered with either an acellular dermal matrix allograft (ADMA) or expanded polytetrafluoroethylene (ePTFE) membrane barrier were left exposed to the oral cavity. Primary coverage was not attempted or obtained in any of the 16 treated sockets. They concluded that ADMA-covered sites resulted in more vital bone present 6 to 8 months post socket treatment than obtained in the ePTFE-covered sites regardless of bone replacement materials used.

Fiorellini et al (2005)[39] conducted a randomised placebo controlled clinical study to evaluate the efficacy of bone induction by two concentration of recombinant human bone morphogenetic protein-2 (rhBMP-2) delivered on

an absorbable collagen sponge ACS *(Helistat*) compared to placebo(ACS alone) and no treatment in a human buccal wall defect model following tooth extraction. rhBMP-2/ACS had significantly greater bone augmentation compared to controls.

Nevins et al (**2006)**[69] compared the fate of the buccal wall of extraction sockets of teeth with prominent roots that received a deproteinized bovine bone mineral *(Bio-Oss, Osteohealth)* with sockets that received no osteogenic material. CT scan results revealed that those sockets treated with Bio-Oss demonstrated a loss of less than 20% of the buccal plate where as in 79% of the cases whereas the control sockets demonstrated a loss of more than 20% of the buccal plate in 71 % of the cases.

Allegrini S Jr et al (2008)[3] reviewed that success or failure of augmentation procedures is dependent on revascularization and remodelling of the grafted bone into a vital, load bearing bone. In contrast to a visible three-dimensional change, the concept of remodelling refers to the internal turnover of bone, which is a coupled process where osteoclastic resorption and osteoblastic formation are more or less balanced

Neiva et al (**2008)**[65] evaluated healing of extraction sockets grafted with a putty form anorganic bovine derived hyroxyapatite matrix combined with a synthetic cell-binding peptide-15 *(PepGen P-15 Putty, DENTSPLY)* and bioresorbble collagen wound dressing material *(colla plug,Zimmer Dental)* to

a control group of the collagen wound dressing alone. The conrol group had amean reduction in ridge height of-o.56+1.04mm whereas test group showed no reduction. The mean reduction in ridge width in test was -1.31+0.96mm and in control it was -1.43+1.05mm.Mean bone density was significantly superior in test group. Histomorphometric analyses revealed similar percentage of bone vitality.

Barone et al (**2008)**[17] studied the horizontal ridge resorption in sockets augmented with corticocancellous porcine bone *(MP3, Osteobiol)* and covered with collagen membrane *(Osteobiol Evolution),* (0.7mm 1.4mm) compared to that of extraction alone (3.6 1.5mm). Histological analysis showed a significantly higher percentage of trabecular bone and total mineralized tissue in ridge preservation sites compared to extraction alone sites 7 months after tooth removal.

Daniele Cardaropoli and Giuseppe Cardaropoli (**2008)**[29] assessed clinically and histologically extraction sockets in the posterior area that received xenograft bone substitute *(Osteobiol,GenOs)* and covered using collagen membrane *(Osteobiol Evolution,Tecnoss*). 85% of the initial ridge dimension was preserved. Histologically new bone formation was detected in all sites, with a 25% average presence of the graft material.

Carlo Mangano et al (**2008)**[61] presented a case report of histological and histomorphometric evaluation of dense HA *(DAC, Dense apatite ceramic)*

in post extraction socket.56% of particles were surrounded partially by bone, whereas 39% were surrounded completely. No fibrous tissue was detected at the bone- biomaterial interface.

Hoffmann et al (**2008)**[47] investigated the clinical regeneration of extraction sockets using high density polytetrafluoroethylene (dPTFE-*Cytoplas ,Regentex GBR-200*) membranes without the use of a graft material. Histological evaluation indicated new bone formation. They concluded that the use of dPTFE membranes predictably led to the preservation of soft and hard tissue in extraction sites.

Wang & Tsao (**2008)**[88] augmented extraction sockets with solvent preserved mineralised cancellous allograft *(Puros cancellous bone, Zimmer Dental)*, and sites were covered with a bioresorbable collagen wound dressing *(Colla-Plug, Zimmer dental)*. Histological evaluation showed formation and remodelling of trabecular bone in areas of the allograft and no signs of inflammation. Histomorphometric analysis showed an average of 68.5%vital bone, 3.8%residual graft particles and 27.7% of connective tissue/ bone marrow.

Molly L et al (**2008)**[64] presented a case series to evaluate bone formation histologically and biomechanically in extraction sites following implantation of a synthetic sponge based on polylactic-polyglycolic acid technology (FIS*)(Fisiograft)* , BPBM (*Bio-oss*® ,*Geistlich*) and a natural

coral derivative physically and chemically transformed into a calcium carbonate ceramic*(Biocoral) and* were covered with polytetrafluoroethylene device (*Goretex).* The percentage of biomaterial was 5.6% for FIS, 20% for BPBM and 12.0% for COR. Histologically, new bone apposition was seen on BPBM particles. FIS sites showed similar ingrowth of blood vessels and osteocytes as empty controls.

Araujo MG and Lindhe J in (2010)[8] experimented the use of autologous bone chips harvested from the buccal bone plate in socket grafting procedure in dog. They concluded that autologous bone chips placed in fresh extraction sockets will i)neither stimulate nor retard new bone formation and ii)not prevent ridge resorption that occurs during healing following tooth extraction.

Araújo MG et al (2010)[9] analyzed processes involved in the incorporation of *beta-tricalcium phosphate* (TCP) particles in host tissue during healing following tooth extraction and grafting. The porosities of the TCP particles were initially filled with erythrocytes that subsequently were replaced with mineralized bone. Some of the graft material was invaded by mesenchymal and inflammatory cells and disintegrated. In the process of hard tissue formation, partly mineralized (modified) TCP particles became surrounded by ridges of woven bone.

Bio-Oss®Collagen

Natural bone grafting material plus collagen

As with Bio-Oss®, the mineral structure of Bio-Oss® Collagen is highly porous, possesses a large internal surface area, and functions as an effective scaffold for bony in-growth and cell adhesion. The collagen component enables convenient handling and simple application of Bio-Oss® particles. In addition, the collagen fibers adhere to the bony recipient site, facilitating formation of a well-formed blood clot. Collagen acts as a natural ligand for keratinocytes and fibroblasts during wound healing. Suspended within a 10% collagen matrix, the Bio-Oss® particles are highly stabilized when placed within a defect site. When moistened with saline or the patient's blood, Bio-Oss®Collagen becomes readily pliable and moldable, facilitating placement within a wide configuration. The spongy consistency of the material allows simple trimming. When placed into the socket, Bio-Oss®Collagen conforms to the defect site facilitating preservation of bone and soft tissue architecture. In course of time Bio-Oss® is partially remodelled by osteoclasts and osteoblasts (physiological remodelling). The collagen is resorbed over several weeks. Additonally, the graft material is well contained within the socket and almost completely eliminates particle migration from the

site thereby supporting the buccal contour of the alveolar ridge and stabilizing the blood clot.

Nevins M et al (2003)[68] evaluated the radiographically and histological response to *Bio-Oss®Collagen* when used alone or in combination with *BioGide* bilayer collagen membrane for the treatment of intrabony defects (5-7mm). Reduction in probing depth and gain in clinical attachment level were observed for both treatment protocols. The histological evaluation demonstrated that bio-Oss collagen has the capacity to induce regeneration of the periodontal attachment apparatus when placed in intrabony defects.

Zitzmann et al (2003)[93] evaluated the effect of a bioresorbable collage membrane *(Bio Gide)* and composite bone graft material deproteinized bovine bone mineral with collagen *(BioOss®Collagen, Geistlich)* in periodontal regeneration of angular bone defects. Results were that residual PD and CAL were reduced to 3.3mm and5.6mm and CAL gain was 3.2mm 24 months postoperatively. Radiographic defect reduction was 4.0mm after surgery and 2.2mm after 24 months.

Hartman et al(2004)[46]evaluated anorganic bovine-derived xenograft (*Bio-Oss® Collagen, Osteohealth*) in the treatment of human periodontal defects. Three of the eight defects examined received a resorbable collagen barrier (*Bio-Gide*) in addition to the bone graft. Six months post surgery

majority of sites showed a favourable clinical response with respect to probing depth reduction and clinical attachment gain. Histologic analysis demonstrated new bone, cementum and periodontal ligament coronal to the reference notch in two of the eight specimens. Two sites demonstrated new attachment, and four showed a long junctional epithelium.

Jung et al (**2004)**[53] analysed the graft enhanced soft tissue healing during initial phases after tooth extraction. The soft tissue punch technique (for harvesting epithelialized free gingival graft) used successfully led to biologic and esthetic integration of the graft (*DBBM integrated in 10% collagen –Bio-Oss*®*Collagen*) into the local host tissues.

Cardaropoli G (2005)[30] in an experimental study in dog evaluated the influence of different biomaterials on the healing of surgically produced bone defects. In defects augmented with *Bio-Oss® Collagen Geistlich* the biomaterial occupied a substantial portion of the tissue volume. 85% of the periphery of the Bio-Oss particles were found to be in direct contact with the newly formed mineralised bone. They concluded that the Bio-Oss Collagen augmented defects exhibited less wound shrinkage than the non-augmented defect.

Fickle et al (2008)[37] evaluated whether tooth extraction with and without the elevation of a mucoperiosteal flap has advantageous effects on the resortion rate after tooth extraction in beagle dogs. The flapless groups

demonstrated significant lower resorption rates both when using socket – preservation techniques and without demonstrating that leaving the periosteum in place decreases the resorption rate of the socket. .Furthermore the treatment of extraction socket with *Bio-Oss® Collagen, Geistlich* yielded better results compared with not treating the socket.

Fickle et al (2007)[36] in an animal study assessed the contour changes after different socket preservation techniques. The treatment groups included graft (*DBBM integrated in 10% collagen –Bio-Oss® Collagen,Geistlich*), graft and free gingival graft no treatment and the internal buccal aspect was covered with an experimental collagen membrane, the socket was filled with graft and the membrane folded on top of the graft. They concluded that socket preservation techniques presented were not able to entirely compensate for the alterations after tooth extraction. Yet, incorporation of Bio-Oss® collagen seems to have the potential to limit but not avoid the postoperative contour shrinkage.

Araujo et al (2008)[6] experimented the effect of Bio-Oss® Collagen in healing of extraction sockets in dog. From results of histomorphometric analysis they concluded that the presence of Bio-Oss Collagen failed to inhibit the process of modelling and remodelling that took place in the socket walls following tooth extraction. However it apparently promoted denovo hard tissue formed particularly in the cortical region of the extraction site.

Nevins et al (**2009)**[70] investigated a minimally invasive surgical procedure for alveolar ridge augmentation that combined recombinant human platelet-derived growth factor BB (rhPDGF-BB) *(Gem 21S, Osteohealth)* and 3 different matrices-FDBA *(University of Miami tissue bank),* ABBG *(Bio-Oss, Osteohealth*) and ABBD/MSCS *(Bio-Oss Collagen, Osteohealth).*The ABBG/MSCS specimens had variable results, with fibrous encapsulation of graft particles and limited histologic evidence of new bone formation.

Araújo MG, Lindhe J. (**2009)**[11] evaluated the long-term effect on hard tissue formation and the amount of ridge augmentation that can occur by the placement of a xenogenic graft *(Bio-Oss® Collagen)* in extraction sockets of dogs compared to contralateral non grafted site. The placement of Bio-Oss®Collagen in the fresh extraction socket served as a scaffold for tissue modelling but did not enhance new bone formation. In comparison with the non-grafted sites, the dimension of the alveolar process as well as the profile of the ridge was better preserved in grafted sites.

Ackermann (2009)[1] in a retrospective case study on extraction site management using *Bio-Oss® Collagen* observed that the soft tissue volume and the contour were largely preserved at all sites, irrespective of the initial defect morphology. The author also reported that Bio-Oss®Collagen presented with predictable preservation of the soft tissues, favourable healing characteristics, and easy handling of the material.

Rasperini et al (2010)[76] compared the dimensional alterations, the need for sinus floor elevation and the histological wound healing of augmented (graft-*Bio-Oss®Collagen* , *Geistlich* and *BioGide* membrane) and nonaugmented sockets. They concluded that the alveolar ridge augmentation increase the possibility of inserting implants without the need for a sinus augmentation procedure.

Araújo et al (2010)[10] analyze d the processes involved in the incorporation of *Bio-Oss® Collagen* in host tissue during healing following tooth extraction and grafting. Histomorphometric analysis revealed that the biomaterial was first trapped in the fibrin network of the coagulum. Neutrophilic leukocytes [polymorphonuclear (PMN) cells] migrated to the surface of the foreign particles. In a second phase the PMN cells were replaced by multinuclear TRAP-positive cells (osteoclasts). The osteoclasts apparently removed material from the surface of the xenogeneic graft. When after 1-2 weeks the osteoclasts disappeared from the Bio-Oss granules they were followed by osteoblasts that laid down bone mineral in the collagen bundles of the provisional matrix. In this third phase the Bio-Oss particles became osseointegrated.

Although socket preservation surgery is beneficial in some cases, soft tissue colour and graft containment are two of the difficulties associated with socket grafting. **McAllister and Haghighat(2007)[63]**

Implant success in regenerated bone

The ultimate goal socket augmentation procedures is successful implant placement. Several studies have examined the long term stability of implants placed in grafted bone.

Fritz et a1 (2001)[41] evaluated the success of implants in regenerated bone from a histologic perspective. Implants were placed in monkeys in both native and regenerated bone and then loaded with a fixed prosthesis for one year. The same radiographic and histologic appearance was seen in both native bone and regenerated bone sites. Also, bone to implant contact showed no significant difference between the implants in native bone (59%) and the implants in regenerated bone (65%).

Fiorellini & Nevins in (2003)[38] conducted a descriptive statistics analysis to evaluate dental implant survival rates in patients treated with ridge augmentation or preservation techniques. Result of the study indicated high level of predictable implant survival in sites treated by GBR or preservation techniques. These survival rates are similar to those of implants placed in native bone. Based on the results of these studies it is clear that implants placed in regenerated bone are just as successful as those placed in native bone

Zafiropoulos et al (2010)[92] in a retrospective study evaluated 241 single implants of tapered and cylindrical screw type in fresh and regenerated extraction sockets. Implants were categorised into immediate placement, delayed placed, immediate non-loading and delayed loading. The authors concluded that the type of implant, position and timing of implant did not influence the survival rate of the above treatment methods.

STUDY DESIGN

Ten systemically healthy patients from the out- patient department, Department of Periodontics and Implantology, Ragas Dental College and Hospital, Chennai, participated in this clinical trial for socket augmentation using block xenograft.

The patients presented with single rooted tooth indicated for extraction. Patients were treated with cancellous- bone block **Bio-Oss® Collagen.**

Patients were clinically assessed preoperatively (before extraction) and reassessed postoperatively for clinical parameters and radiographically using IOPA and RVG at 3 months and 6 months time interval.

Clinical examinations were performed at follow up visits to check for complications including infections, inflammation, wound dehiscence and resorption.

The clinical measurements of the extraction socket (bucco-lingual width) were measured using a surgical bone calliper. Other measurements were measured using standard Williams probe, reamer and divider. Customised acrylic vacuum stent was fabricated for standardisation of the measurements and reproducibility during the recall visits.

PATIENT SELECTION

10 systemically healthy patients (4 females and 6 males) in the age group of 25-55 years with teeth indicated for extraction and future implant placement were selected.

INCLUSION CRITERIA

1. Patients with teeth indicated for extraction and future implant therapy. Teeth included incisors, canines and premolars. The reasons for extraction were root fractures, failed endodontic treatment and advanced dental caries.
2. Intact adjacent and opposing teeth.
3. Patients with good general health and no contraindications to surgical procedures under local anaesthesia were included in the study.

EXCLUSION CRITERIA

1. Acute or chronic infection at the surgical site.
2. The presence of uncontrolled metabolic disorders, autoimmune disease or any contraindicating systemic disease.
3. Radiation therapy to the head and neck region 12 months prior to the proposed therapy.

4. Prolonged corticosteroid therapy and other medications.

5. Smoking.

6. Pregnant and lactating women.

7. Patient unwilling for implant therapy and for long term follow up.

ARMAMENTARIUM

1. Mouth mirror
2. Equinox Williams periodontal probe with marking of 10mm
3. Surgical bone calliper (***Medyssey,*** marking 0-15mm)
4. Metallic scale
5. Divider
6. Reamer
7. Tweezers
8. Custom made acrylic stent
9. 3 ml disposable syringes (unilock)-1 ½ inch
10. Dappen dish -1No.
11. Kidney tray - 1 No.
12. 20 ml saline irrigation syringes -1 Nos.
13. Normal physiologic saline 500 ml bottles (0.9%w/v)
14. 0.2%chlorhexidine mouthrinse
15. Disposable suction tips
16. 2% lignocaine hydrochloride with 1:80000 adrenalines
17. Bard Parker handle No.3-1 nNo
18. Bard Parker blade No.15
19. Austin's cheek retractor
20. Periosteal elevator
21. Surgical curettes

22. Curved goldman fox scissors

23. Tissue holding forceps

24. **Periotomes**

25. Trephine bur

26. Formalin

27. Needle holder

28. 3-0 mersilk non-resorbable sutures)

29. ATR physiodispenser with internal irrigation system

30. Endopore implant system with implants

MATERIALS

Bio-Oss®Collagen. (100 mg) *(Geistlich)*

Bio-Oss ® is a natural bone material of bovine origin. The highly purified *osteoconductive* mineral structure is produced from the natural bone in a multi-stage purification process, adhering to safety regulations. Bio-Oss® is available as *granulate of cancellous bone* and as a *cancellous-bone block.*

Because of its origin, Bio-Oss® is chemically as well as structurally comparable to the mineralised human bone

Bio-Oss® Collagen is a mixture of **cancellous-bone granulate and 10% porcine collagen** fibres in a block form**.**

CLINICAL PARAMETERS

All clinical data regarding hard and soft tissue dimensions at the augmented socket sites were recorded at each visit by one calibrated examiner. All measurements were made to the nearest 0.5mm using a standard surgical bone calliper and Williams periodontal probe, reamer and divider, and the measurements were transferred.

The acrylic reference stent was fabricated for each patient to assist in the standardisation of the measurements. Acrylic vacuum stent with reference points was used for the buccolingual crest width measurement.[76] The stent for measuring width of attached gingiva was designed to cover the occlusal surface of teeth adjacent to the surgical site. An orthodontic wire, extending between the occlusal surfaces was acrylised to the stent. A marking was made on the wire corresponding to the centre of the ridge.[82]

Soft tissue measurements

The following soft tissue measurements were taken at baseline, 3 months and 6 months

1. **Distance between the tip of the papilla to the proximal CEJ of adjacent teeth**

   Measured at four regions, mesiobuccal , mesiopalatal , disto buccal and disto palatal.

2. **Distance between the midpoint of gingival margin and buccal / palatal CEJ of adjacent teeth**.

   Four measurements were obtained.

   From mesial tooth-buccal and palatal

   From distal tooth –buccal and palatal

3. **Width of keratinised gingiva.**

   Distance measuring from cementoenamel junction of the adjacent teeth to the mucogingival junction was measured at mid buccal region of the extraction site was calculated during baseline, 3 month and 6 month period.

4. **Gingival thickness**

   At the midbuccal region of the extraction site, thickness was measured with a reamer at baseline, 3 months and 6 months.

Hard tissue measurements

1. **Extraction socket labial plate vertical position**

   At baseline (immediately after extraction) and at 6 months (during implant placement) following flap elevation the distance between the facial CEJ (midpoint) of the adjacent teeth to the mid

buccal point on the buccal plate of the extraction socket is measured using a divider and the measurement is transferred.

2. Horizontal width (bucco-loingual crest width)

At baseline, 3months and 6 months, the bucco lingual width of the alveolar ridge is measured using a standard surgical bone calliper at four regions

at 2mm from the crest

- mesial, midbuccal and distal

at 4 mm from the crest

- midbuccal

as indicated by the reference holes in the acrylic stent.

3. Number of walls

The existing walls of the socket and marginal resorption of any of the walls, if present were noted immediately after extraction.

SURGICAL PROCEDURE

Informed consent was obtained from all patients prior to implementing the surgical procedure. Surgery was carried out under strict aseptic condition with 10ml of 0.2% Chlorhexidine mouth rinse.

Local anaesthesia with Lignocaine hydrochloride 2% with Adrenaline 1:80000 was administered at the surgical site.

A sulcular incision was made circumferentially around the tooth to be extracted to severe supracrestal attachment apparatus. The tooth was extracted using dental forceps following luxation with a periotome, taking care to avoid labial plate fracture and preservation of the interdental papillae. Debridement of granulation tissue within the socket using sharp surgical curette was done. A mucoperiosteal flap was raised buccally at the extraction site.

After mixing of the graft with saline or patient's blood the extraction socket was filled with Bio-Oss® Collagen block. Trimming of the block graft was done if required .The buccal flap was coronally repositioned and sutured to obtain primary closure.[44]

POSTOPERATIVE CARE

Patients were prescribed postoperative antibiotics and analgesic.

Amoxicillin 500mg one tablet thrice daily for 5 days and Ibuprofen 400 mg thrice daily for 3 days. Patients were instructed to use external icepack for 3 hours intermittently and a soft diet for the first few weeks and avoidance of stretching the surgical area. Patients were instructed to limit tooth brushing at the surgical site. Chemical plaque control with 10ml of 0.2% Chlorhexidine rinse for 10days was instructed. Sutures were removed after two weeks.

RECALL VISITS

Of the 10 patients who were treated for socket augmentation, one of the patients presented with granulomatous tissue formation within the extraction socket 3 days postoperatively. The patient did not complain of pain or swelling. The tissue was excised and buccal flap advanced to achieve primary closure. The tenth patient is still under the post operative recall period(2 months).

Rest of the patients were recalled at 1, 3 and 6 months time interval. Hard and soft tissue parameters were recorded and tabulated at the third and sixth month. Oral hygiene instructions were reinforced. In 3 patients, provisional acrylic prosthesis was bonded to the neighbouring teeth. After

3 months, the mucosa covering the edentulous ridge and the gingival tissues at the adjacent teeth appeared to be clinically healthy.

SURGICAL RE-ENTRY

Implant placement was carried out after the 6 month post operative period (between 7-9 month) in 8 of the patients. Local anaesthesia was administered with 2% Lignocaine HCl in 1:80000 Adrenaline. Crestal incisions with extending crevicular incisions on two teeth on either side of the edentulous sites were placed. Full thickness mucoperiosteal flap was reflected and the augmented underlying bone was visualized and new dimension was recorded using the calliper, 2mm and 4mm from the crest. Biopsy specimen was harvested for each augmented extraction socket with the purpose of histological evaluation using trephine bur. The biopsy specimen was placed in 10% formalin and the bottles were appropriately sealed and labelled.

Specimens from 8 of the 10 augmented sites were evaluated for new bone formation. The samples were processed and sectioned to appropriate thickness (longitudinal sections) and subsequently stained with Hematoxylin and Eosin for evaluation under light microscopy.

Endopore endosseous implants were subsequently placed in the augmented site according to the ridge width and height and the flaps were approximated and sutured with 3-0 Mersilk non-resorbable sutures.

RAGAS DENTAL COLLEGE AND HOSPITAL, CHENNAI.

DEPARTMENT OF PERIODONTICS

PROFORMA

Serial no.

Name: **Age/Sex:**

Address: **Date:**

Phone No:

Chief Complaint:

History of Chief Complaint:

Past Dental History:

Past Medical History:

Clinical examination:

1. Extraction site:

2. Reason for extraction:

3. Periodontal status of neighbouring teeth:

Investigations:

1. Radiological

a. IOPA

b. Others

2. Laboratory

a. Total count

b. Differential count

c. Hemoglobin

d. Clotting time

e. Bleeding time

f. Blood sugar

g. Blood pressure

Clinical parameters

SOFT TISSUE PARAMETERS:

Parameters	Baseline(mm)		3 months(mm)		6 months(mm)	
	mesial	distal	mesial	distal	mesial	distal
Distance between tip of papilla and CEJ (buccal)						
Distance between tip of papilla and CEJ (palatal)						
Distance between CEJ of adjacent teeth and gingival margin (buccal)						
Distance between CEJ of adjacent teeth and gingival margin (palatal)						
Width of keratinised gingiva						
Gingival thickness						

HARD TISSUE PARAMETERS:

Parameters	Baseline(mm)			3 months(mm)			6 months(mm)		
	Mesio buccal	Mid buccal	Disto buccal	Mesio buccal	Mid buccal	Disto buccal	Mesio buccal	Mid buccal	Disto buccal
Buccolingual crest width at 2mm									
Buccolingual crest width at 4mm (mid buccal)									

Extraction socket labial plate vertical position:

Baseline(mm)		6 months(mm)	
mesial	distal	mesial	distal

Number of walls:

INFORMED PATIENT CONSENT

RAGAS DENTAL COLLEGE AND HOSPITAL, CHENNAI.

DEPARTMENT OF PERIODONTICS

Patient Name: **Age:**

Sex:

I have been clearly explained and informed regarding the following surgical procedure to be performed on myself (*socket preservation with Bio-Oss® Collagen and implant therapy*) in the language known to me (.....) and I have no objection for the treatment and if the treatment shows no anticipated results, I agree to undergo suitable/alternative method for the same. I give my consent for photographs and radiographs to be taken at the beginning, during, and at the end of the study.

PLACE:

DATE: **SIGNATURE OF PATIENT.**

SIGNATURE OF P.G STUDENT.

SIGNATURE OF GUIDE.

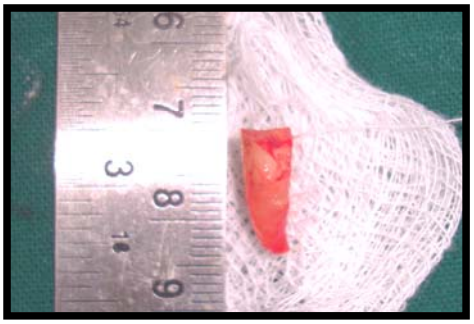
SIGNATURE OF H.O.D.

CASE #1

PRE OPERATIVE

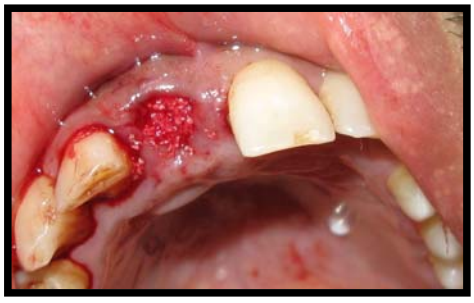
OPERATIVE

EXTRACTION SOCKET

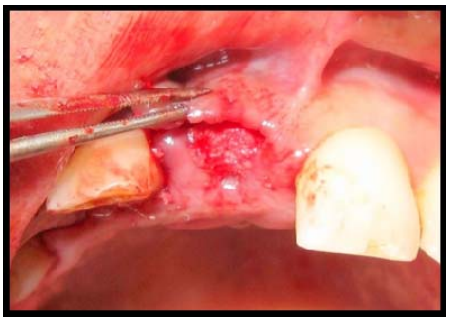


EXTRACTED 11

BIO-OSS®COLLAGEN BLOCK GRAFT



GRAFT PLACED WITHIN SOCKET

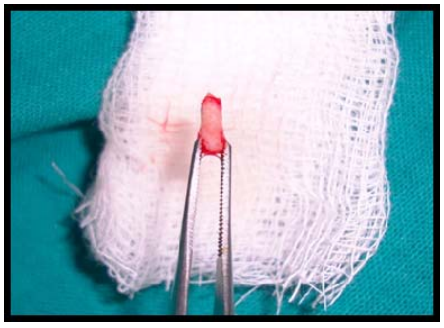


BUCCAL FLAP ELEVATED

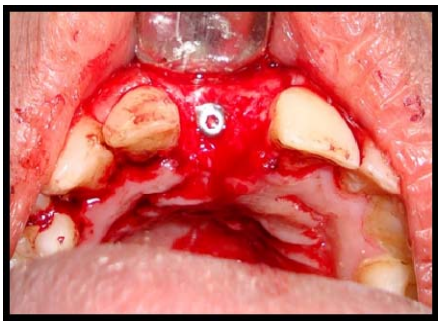
SUTURES PLACED

POST OPERATIVE (6 MONTHS)

SURGICAL RE ENTRY



TREPHINED BONE SPECIMEN

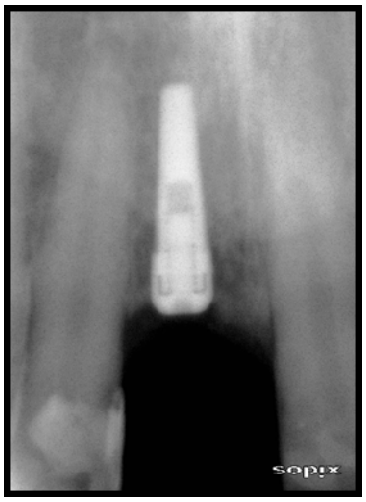


IMPLANT PLACED

BASELINE

3 MONTHS

6 MONTHS



IMPLANT 4.1x12mm

CASE #2

PREOPERATIVE

POST OPERATIVE (6 MONTHS)

BASELINE

3 MONTHS

6 MONTHS

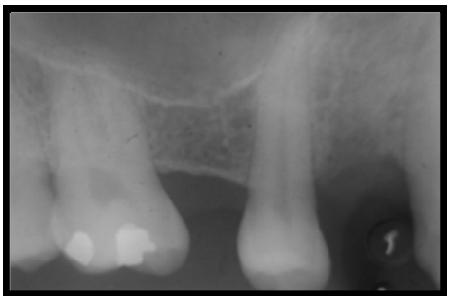
IMPLANT 3.5mm X 9mm

CASE #3

PREOPERATIVE

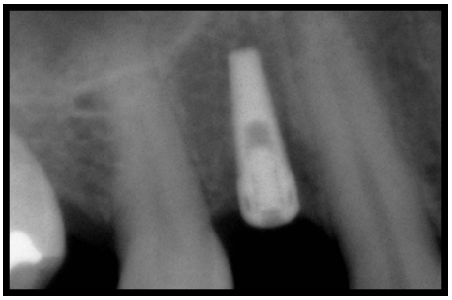
POST OPERATIVE (6 MONTHS)

BASELINE



3 MONTHS

6 MONTHS

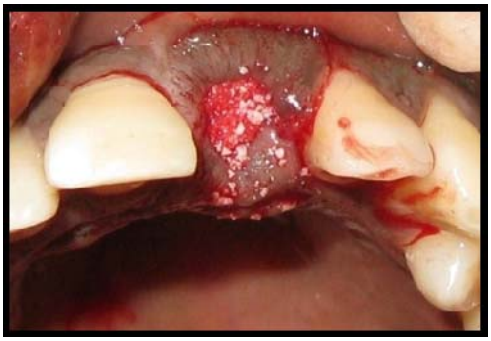


IMPLANT: 3.5mm X 9mm

CASE #4

PREOPERATIVE

OPERATIVE

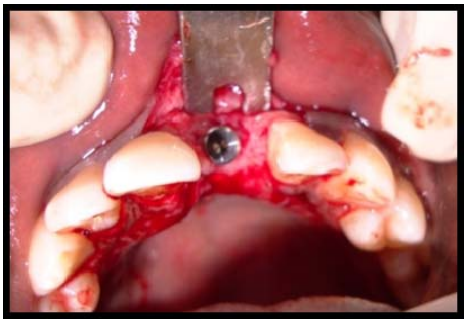


PLACEMENT OF BIO-OSS®COLLAGEN

SUTURES PLACED

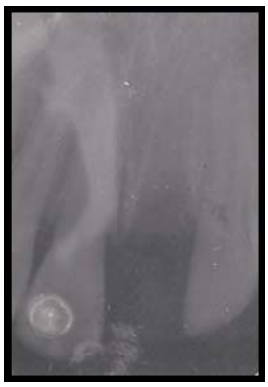
POST OPERATIVE (6MONTHS)

SURGICAL RE-ENTRY



HARVESTING OF BONE SPECIMEN USINGTREPHINEBUR

IMPLANT PLACED



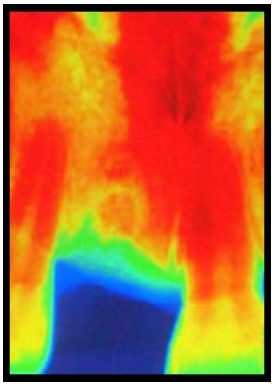
BASELINE

3 MONTHS

6 MONTHS

IMPLANT 4.1x12mm

RVG IMAGES



CASE #5

PREOPERATIVE

OPERATIVE

ATRAUMATIC EXTRACTION USING PERIOTOME

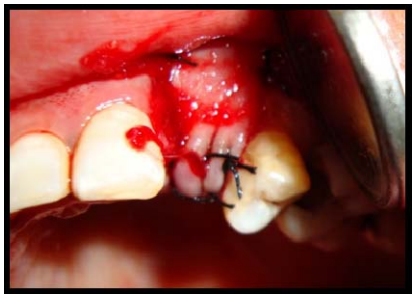
EXTRACTION SOCKET

PLACEMENT OF BIO-OSS®COLLAGEN

SUTURES PLACED

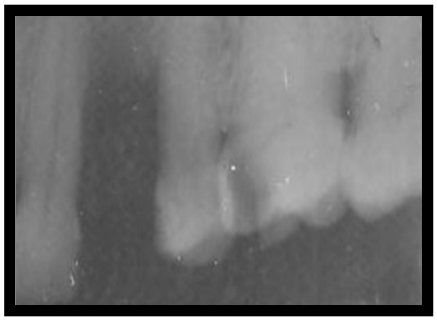
POST OPERATIVE (3 DAYS)

SURGICAL EXCISION



POST OPERATIVE (6 MONTHS)

BASELINE

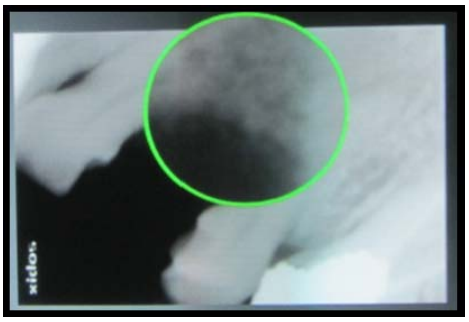


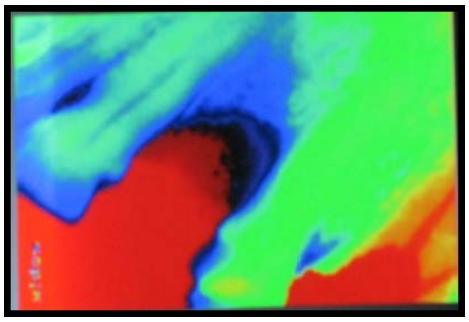
3 DAYS

3 MONTHS

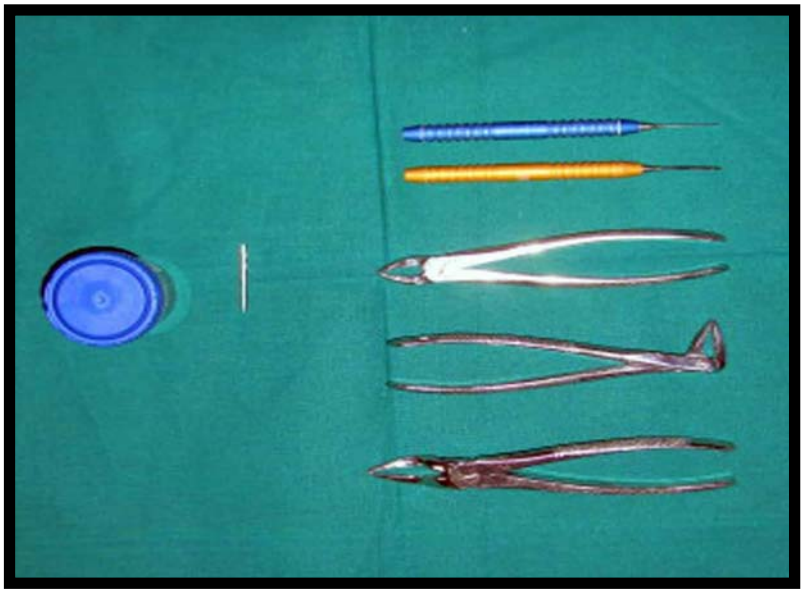
6 MONTHS

RVG IMAGES

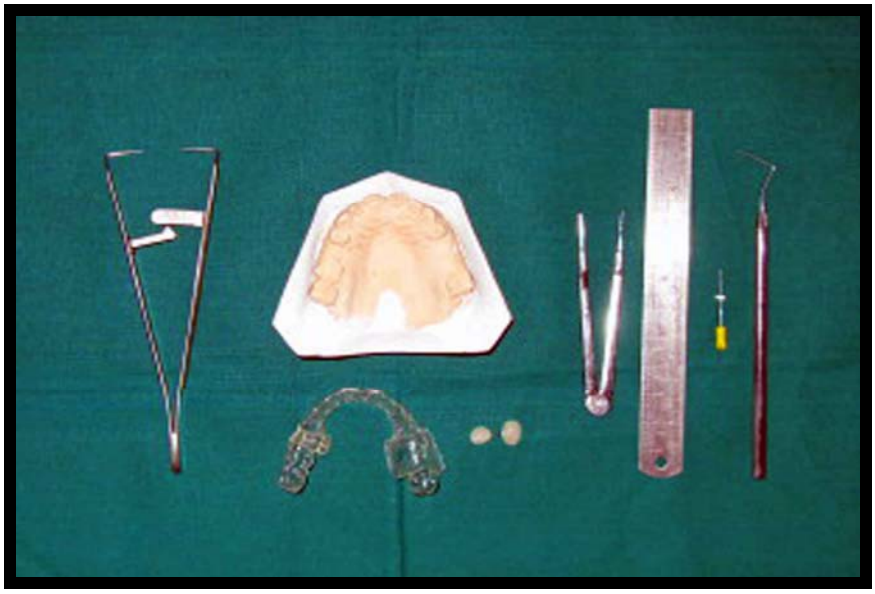




SURGICAL ARMAMENTARIUM



PERIOTOMES, EXTRACTION FORCEPS, TREPHINE BUR, FORMALIN



CUSTOMIZED ACRYLIC STENT AND MEASURING INSTRUMENTS

PHYSIODISPENSER WITH INTERNAL IRRIGATION SYSTEM

CANCELLOUS BLOCK XENOGRAFT

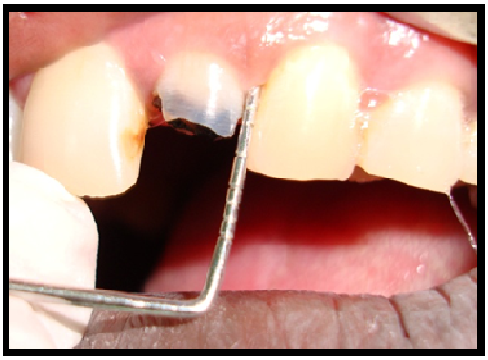
BIO-OSS® COLLAGEN (100mg)

RESULTS

DISTANCE BETWEEN TIP OF PAPILLA TO PROXIMAL CEJ OF ADJACENT TEETH- BUCCAL & PALATAL

serial number	baseline(mm)		3 months(mm)		6 months(mm)	
	mesial	distal	mesial	distal	mesial	distal
1	2	2	1	1	1	1
2	2	2	1	1	1	1
3	2	2	1	1	1	1
4	2	2	1	1	1	1
5	2	1	1	0	1	0
6	1	0	0	0	0	0
7	2	2	1	1	1	1
8	1	1	0	0	0	0
9	2	2	1	1	1	1
10	-1	0				

serial number	baseline(mm)		3 months(mm)		6 months(mm)	
	mesial	distal	mesial	distal	mesial	distal
1	2	2	1	1	1	1
2	2	2	1	1	1	1
3	2	2	1	1	1	1
4	2	2	1	1	1	1
5	2	1	1	0	1	0
6	1	0	0	0	0	0
7	2	2	0	1	0	1
8	2	2	1	1	1	1
9	2	2	1	1	1	1
10	-1	0				



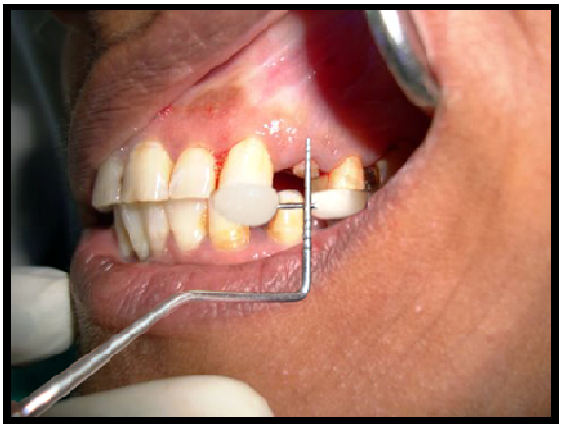
DISTANCE BETWEEN CEJ OF ADJACENT TEETH TO GINGIVAL MARGIN

serial number	baseline(mm)		3 months(mm)		6 months(mm)	
	mesial	distal	mesial	distal	mesial	distal
1	7	7	7	7	7	7
2	6	6	7	7	7	7
3	6	6	6	7	6	7
4	7	7	7	8	7	8
5	7	6	7	7	7	7
6	7	7	8	8	8	8
7	6	7	7	7	7	7
8	7	7	9	9	9	9
9	7	6	9	8	9	8
10	8	8				

serial number	baseline(mm)		3 months(mm)		6 months(mm)	
	mesial	distal	mesial	distal	mesial	distal
1	6	6	6	6	6	6
2	6	5	6	5	6	5
3	5	5	5	6	5	6
4	5	5	6	6	6	6
5	5	5	5	5	5	5
6	6	5	6	5	6	5
7	5	5	5	5	5	5
8	6	5	5	5	5	5
9	5	5	7	6	7	6
10	6	6				

WIDTH OF KERATINISED GINGIVA AT DIFFERENT TIME INTERVALS

serial.no	Baseline(mm)	3 months(mm)	6 months(mm)
1	5	3	3
2	3	2	2
3	4	3	3
4	4	3	3
5	4	3	3
6	4	3	3
7	4	3	3
8	4	1	1
9	4	3	3
10	4		



GINGIVAL THICKNESS AT DIFFERENT TIME INTERVALS

serial.no	Baseline(mm)	3 months(mm)	6 months(mm)
1	1.5	1.5	1.5
2	1.5	1.5	1.5
3	1.5	1.5	1.5
4	1.5	1.5	1.5
5	1	1	1
6	1.5	1.5	1.5
7	1.5	1.5	1.5
8	1.5	2.5	2.5
9	1.5	1.5	1.5
10	1.5		

BUCCOLINGUAL CREST WIDTH AT 2MM

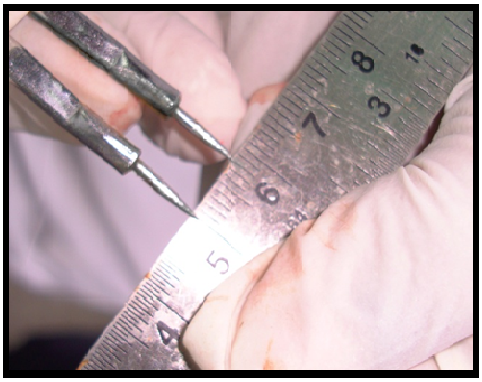
serial number	baseline(mm)			3 months(mm)			6 months(mm)		
	MB	MB	DB	MB	MB	DB	MB	MB	DB
1	7	7	7	6	5	6	6	5	6
2	7	7	7	6	5	6	6	5	6
3	7	8	8	7	7	7	7	7	7
4	7	8	8	7	7	7	7	7	7
5	8	9	9	8	8	8	8	8	8
6	9	10	9	8	8	8	8	8	8
7	5	6	5	5	5	5	5	5	5
8	7	8	7	5	5	5	5	5	5
9	7	7	7	6	5	6	6	5	6
10	5	6	5						

BUCCOLINGUAL CREST WIDTH AT 4MM (MIDBUCCAL)

serial.no	Baseline(mm)	3 months(mm)	6 months(mm)
1	9	9	9
2	9	8	8
3	10	10	10
4	10	10	10
5	11	11	11
6	12	11	11
7	8	8	8
8	10	8	8
9	9	8	8
10	7		

EXTRACTION SOCKET VERTICAL LABIAL PLATE POSITON

Serial.no	baseline (mm)		6 months(mm)	
	MESIAL	DISTAL	MESIAL	DISTAL
1	7	7	8	7
2	7	7	8	9
3	7	7	7	8
4	7	6	7	7
5	7	7	8	8
6	7	7	8	8
7	7	7	7	8
8	7	7	-	-
9	7	7	8	9
10	7	7		



PHOTOMICROGRAPHS

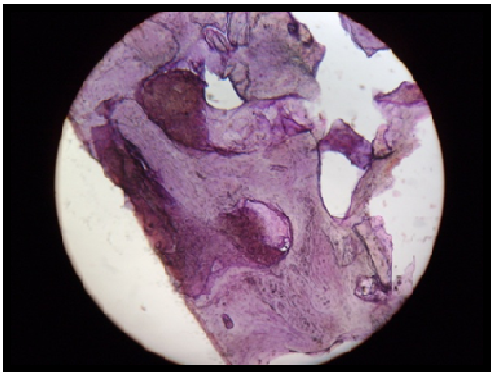


Fig a

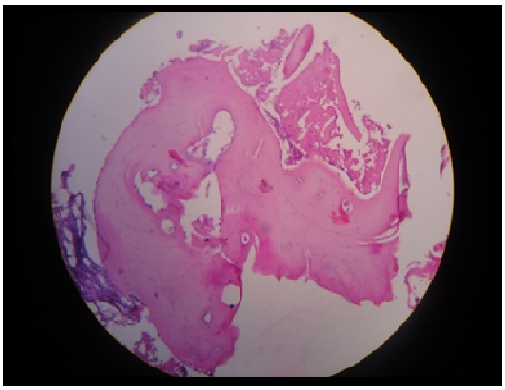


Fig b

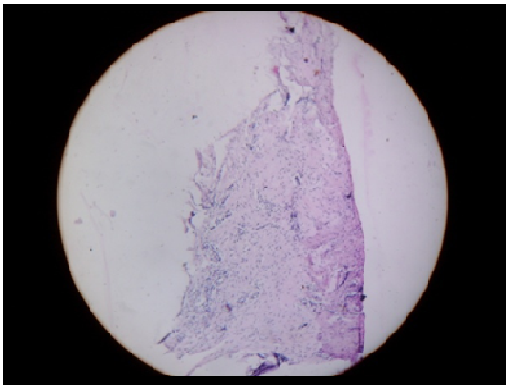


Fig c

HISTOLOGICAL ANALYSIS

A minimum quantum of augmented bone that was removed during implant placement was subjected to histological evaluation by light microscopy, after necessary processing of the tissues.

Out of the 8 biopsy samples, 5 samples revealed vital bone with minimal amounts of non-refractile material suggestive of the graft material **(Fig.a).** 2 of the specimens showed fibrous connective tissue exhibiting a mixed inflammatory cell infiltrate. Non refractile material suggestive of xenograft material in the connective tissue and spicules of vital bone containing marrow spaces were observed **(Fig.b).** In the biopsy specimen collected from the patient who presented with graft encapsulation on radiographic assessment, the microscopic features revealed fibrous connective tissue and few areas with spherules and spicules of calcified material suggestive of bone (**Fig.c).**

STATISTICAL ANALYSIS

Data was expressed as mean ± standard deviation of the parameters evaluated. Clinical parameters were recorded at baseline, 3rd month and 6th month post operatively. Comparisons were made within each group between baseline,3rd month and 6th month using the **Wilcoxon Signed-Rank Sum Test.**

In the present study **p Value <0.05** was considered as significant at 5% level of significance.

RESULTS OF STATISTICAL ANALYSIS

This study recruited 10 healthy patients who exhibited single rooted teeth indicated for extraction. All patients were treated with a cancellous-bone block xenograft (Bio-Oss® Collagen) .The patients were evaluated clinically and histological analysis of the augmented bone obtained during implant surgery. The following results were obtained:

DISTANCE BETWEEN THE TIP OF THE PAPILLA TO THE CEJ OF THE ADJACENT TOOTH –BUCCAL (mm):

The mean distance between the tip of the papilla and the proximal CEJ of both the mesial and distal adjacent teeth buccally measured at baseline was 1.75 mm ±0.53. At the end of the 3month period there was a mild though significant decrease (0.81mm ±0.71) in the distance ,which was maintained till the period of study (6 month 0.81mm ±0.71).The difference was however statistically significant at p Value <0.01(table -1, graph-1)

DISTANCE BETWEEN THE TIP OF THE PAPILLA TO THE CEJ OF THE ADJACENT TOOTH –PALATAL (mm):

Similar results as on the Buccal side, were obtained mean baseline values (1.75mm ±0.53) tended to decrease in 3months (0.75mm ±0.38) which was maintained till the end of 6 months (0.75mm ±0.38). There was statistical significant difference observed (p<0.01) (table -2, graph-1)

THE DISTANCE BETWEEN THE CEJ OF THE ADJACENT TOOTH TO THE GINGIVAL MARGIN - BUCCAL (mm):

The mean value of the distance between the buccal CEJ of the mesial and distal adjacent teeth to the gingival margin measured on the buccal aspect at baseline measured 6.56mm ±0.42. At the end of 3 months, a slight increase in the measurements (7.31mm ±0.65) which was of statistical significant difference ($p<0.05$) was noticed. Similar measurements were observed at 6 months (7.31mm ±0.65) (table -3, graph-2)

THE DISTANCE BETWEEN THE CEJ OF THE ADJACENT TOOTH TO THE GINGIVAL MARGIN – PALATAL (mm):

The mean value of the distance between the CEJ of the mesial and distal adjacent teeth to the gingival margin measured on the palatal aspect at baseline was 5.25 mm ±0.38 at the end of 3 months there was only a marginal increase (5.63mm ±0.52) which was maintained till the 6 month(5.63 mm±0.52) the difference was not statistically significant ($p>0.05$) (table -4 , graph-2)

WIDTH OF KERATINIZED GINGIVA (mm):

At baseline the mean width of keratinized gingiva was 4.00 mm ±0.54 .At the end of 3 months there was a reduction in the mean width (2.88 mm ± 0.35)which remained stable till the end of 6 months (2.88 mm ± 0.35). It was statistically significant ($p<0.01$) (table -5, graph- 3)

GINGIVAL THICKNESS (mm) :

Mean baseline values (1.44mm ±0.18)were observed without change till the 3 month period (1.44mm ±0.18) and maintained at the same thickness (1.44mm ±0.18) at the end of the study period , showing no statistical significance ($p>0.05$) (table -6, graph-4)

BUCCOLINGUAL CREST WIDTH AT 2MM – MESIOBUCCAL (mm):

The mean buccolingual crest width values at 2 mm at baseline measured (7.12 mm ±1.13) and at 3 months there was a slight decrease in the mean values (6.62 mm ±1.06) which was maintained till the 6 month period (6.62 mm ±1.06). This was however statistically significant ($p<0.05$) (table -7, graph-5)

BUCCOLINGUAL CREST WIDTH AT 2MM–MIDBUCCAL (mm):

The mean crestal width values measured midbuccally at 2 mm at baseline was seen to be 7.75mm ±1.28 .At the 3rd month recall a decrease in the values were observed (6.25mm ±1.39) which remained the same at the end of the 6th month (6.25mm±1.39) showing statistical significance with the baseline values ($p<0.05$) (table -7, graph- 5)

BUCCOLINGUAL CREST WIDTH AT 2MM – DISTOBUCCAL (mm):

The mean crestal width values measured at 2 mm distobuccally were 7.50mm ±1.31. At the end of 3 months there was a slight decrease (6.62mm ±1.06) which was maintained till the 6th month (6.62 mm ±1.06).

The recall results shows statistical significant difference with the baseline ($p<0.01$) (table -7, graph-5)

BUCCO LINGUAL CREST WIDTH AT 4 MM (mm):

Mean crestal width values measured buccolingually at 4mm however exhibited very mild differences in values clinically from baseline (9.75mm ±1.28);at 3 months (9.38mm ±1.30) but at the 6th month recall period these values remained unchanged (9.38mm ±1.30) . The difference was not statistically significant ($p>0.05$) (table -8, graph- 6)

EXTRACTION SOCKET LABIAL PLATE VERTICAL POSITION (mm):

The mean value of the vertical plate labial position measured 6.94mm ±0.17 at baseline while at the end of 6 months an increase in the mean value was observed (7.44mm ±0.39). The difference was of statistical significance ($p<0.05$) (table -9, graph-7).

TABLE#1

COMPARISON OF MEAN DISTANCE BETWEEN TIP OF PAPILLA TO CEJ OF ADJACENT TEETH -BUCCAL (mm)

EXTRACTION SITE	N	MEAN	SD	P VALUE
baseline	8	1.75	0.53	0.007**
3 months	8	0.81	0.37	
6 months	8	0.81	0.37	

**p Value is <0.01 which denotes1% level of statistical significance

TABLE#2

COMPARISON OF MEAN DISTANCE BETWEEN TIP OF PAPILLA TO CEJ OF ADJACENT TEETH -PALATAL (mm)

EXTRACTION SITE	N	MEAN	SD	P VALUE
baseline	8	1.75	0.53	0.008**
3 months	8	0.75	0.38	
6 months	8	0.75	0.38	

**p Value is <0.01 which denotes1% level of statistical significance

TABLE# 3

COMPARISON OF MEAN DISTANCE BETWEEN CEJ OF ADJACENT TEETH TO GINGIVAL MARGIN - BUCCAL (mm)

EXTRACTION SITE	N	MEAN	SD	P VALUE
baseline	8	6.56	0.42	0.016*
3 months	8	7.31	0.65	
6 months	8	7.31	0.65	

*p Value is <0.05 which denotes 5% level of statistical significance

TABLE#4

COMPARISON OF MEAN DISTANCE BETWEEN CEJ OF ADJACENT TEETH TO GINGIVAL MARGIN - PALATAL (mm)

EXTRACTION SITE	N	MEAN	SD	P VALUE
baseline	8	5.25	0.38	0.109
3 months	8	5.63	0.52	
6 months	8	5.63	0.52	

P Value is >0.05 which denotes no statistical significance at 5%

TABLE#5

COMPARISON OF WIDTH OF KERATINISED GINGIVA AT DIFFERENT TIME INTERVALS (mm)

EXTRACTION SITE	N	MEAN	SD	P VALUE
baseline	8	4.00	0.54	0.007**
3 months	8	2.88	0.35	
6 months	8	2.88	0.35	

**p value is <0.01 which denotes1% level of statistical significance

TABLE#6

GINGIVAL THICKNESS (mm)

EXTRACTION SITE	N	MEAN	SD	P VALUE
baseline	8	1.44	0.18	1.000
3 months	8	1.44	0.18	
6 months	8	1.44	0.18	

p Value is >0.05 which denotes no statistical significance at 5%

TABLE-#7

COMPARISON OF BUCCOLINGUAL CREST WIDTH AT 2MM-MESIOBUCCAL, MIDBUCCAL & DISTOBUCCAL (mm)

EXRTRACTION SITE	Baseline			3months			6 months			P VALUE
	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	
MESIOBUCCAL	8	7.12	1.13	8	6.62	1.06	8	6.62	1.06	0.046*
MIDBUCCAL	8	7.75	1.28	8	6.25	1.39	8	6.25	1.39	0.010*
DISTOBUCCAL	8	7.50	1.31	8	6.62	1.06	8	6.62	1.06	0.008**

* p Value is <0.05 which denotes 5% level of statistical significance

** p Value is <0.01 which denotes1% level of statistical significance

TABLE#8

COMPARISON OF BUCCOLINGUAL CREST WIDTH AT 4MM-MIDBUCCAL (mm)

EXTRACTION SITE	N	MEAN	SD	P VALUE
baseline	8	9.75	1.28	0.083
3 months	8	9.38	1.30	
6 months	8	9.38	1.30	

p Value is >0.05 which denotes no statistical significance at 5%

TABLE#9

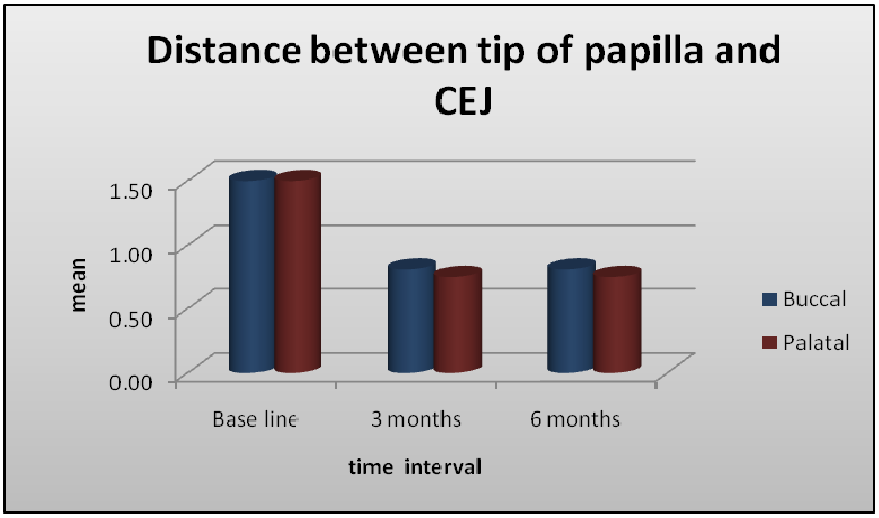
COMPARISON OF MEAN LABIAL PLATE VERTICAL POSITION (mm)

EXTRACTION SITE	N	MEAN	SD	P VALUE
baseline	8	6.94	0.18	0.011*
6 months	8	7.81	0.53	

*p Value is <0.05 which denotes 5% level of statistical significance

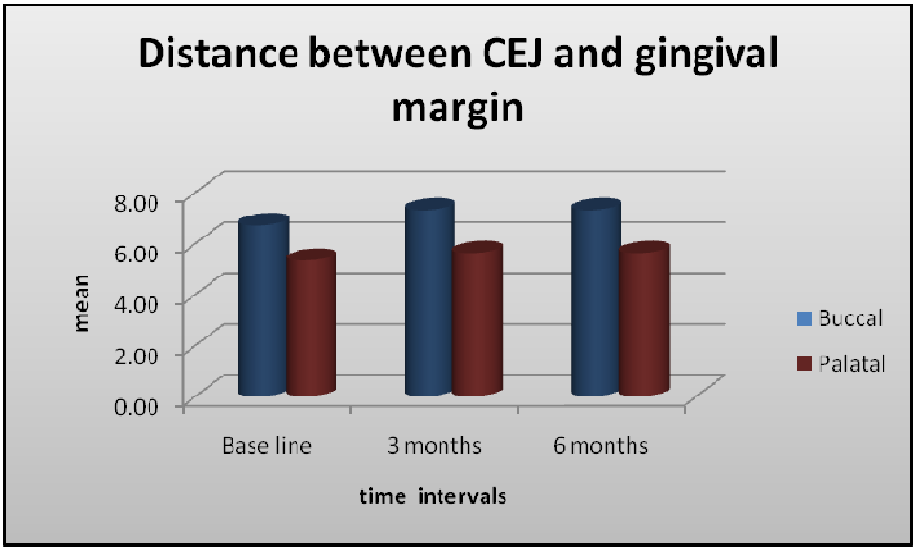
GRAPH #1

COMPARISON OF THE MEAN DISTANCE BETWEEN TIP OF PAPILLA AND CEJ OF ADJACENT TEETH-BUCCAL AND PALATAL (mm) AT DIFFERENT TIME INTERVALS



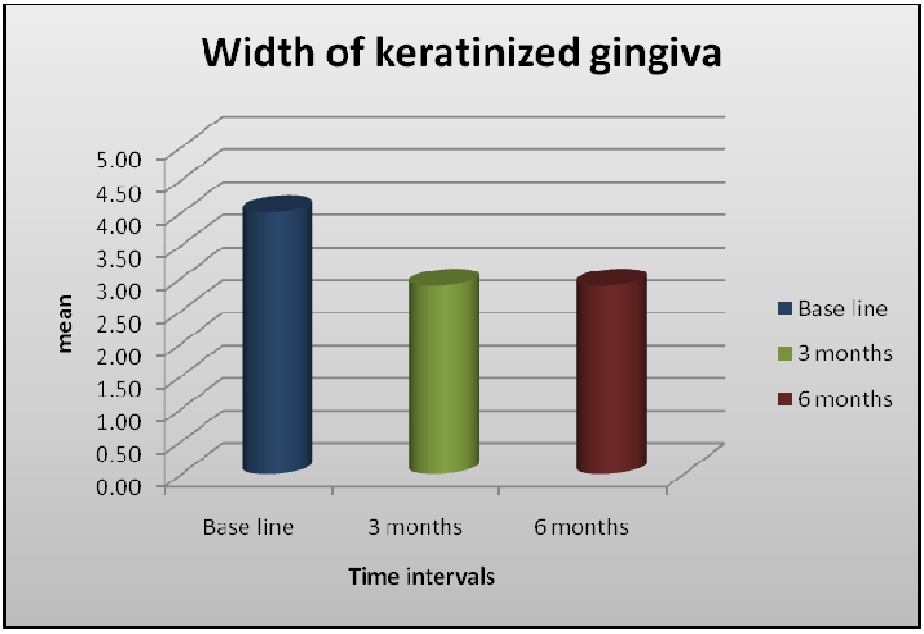
GRAPH #2

COMPARISON OF THE MEAN DISTANCE BETWEEN CEJ OF ADJACENT TEETH AND GINGIVAL MARGIN-BUCCAL AND PALATAL (mm) AT DIFFERENT TIME INTERVALS



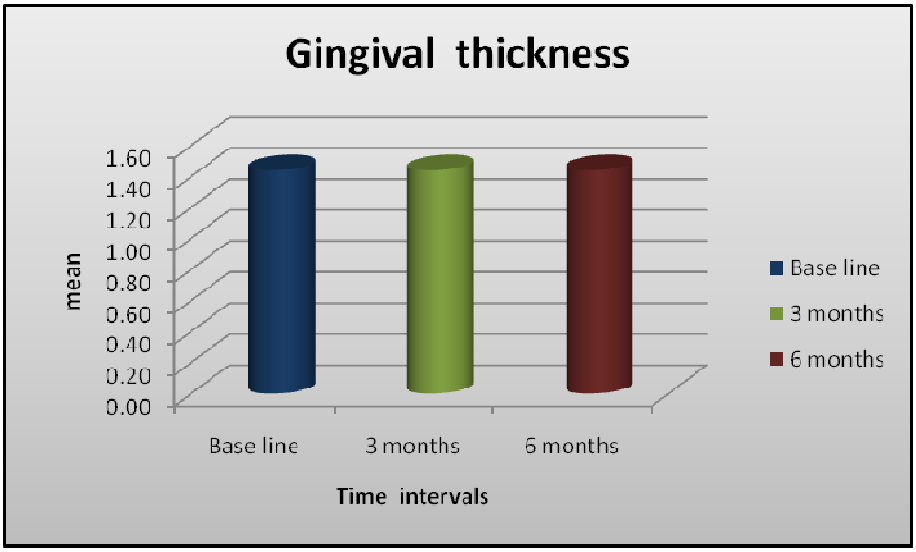
GRAPH #3

COMPARISON OF THE MEAN WIDTH OF KERATINIZED GINGIVA (mm) AT DIFFERENT TIME INTERVALS



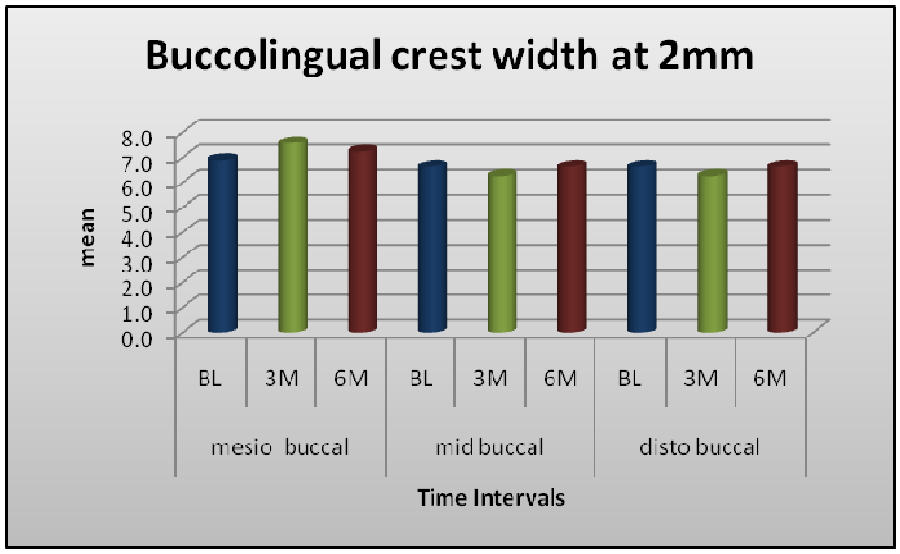
GRAPH #4

COMPARISON OF THE MEAN GINGIVAL THICKNESS (mm) AT DIFFERENT TIME INTERVALS



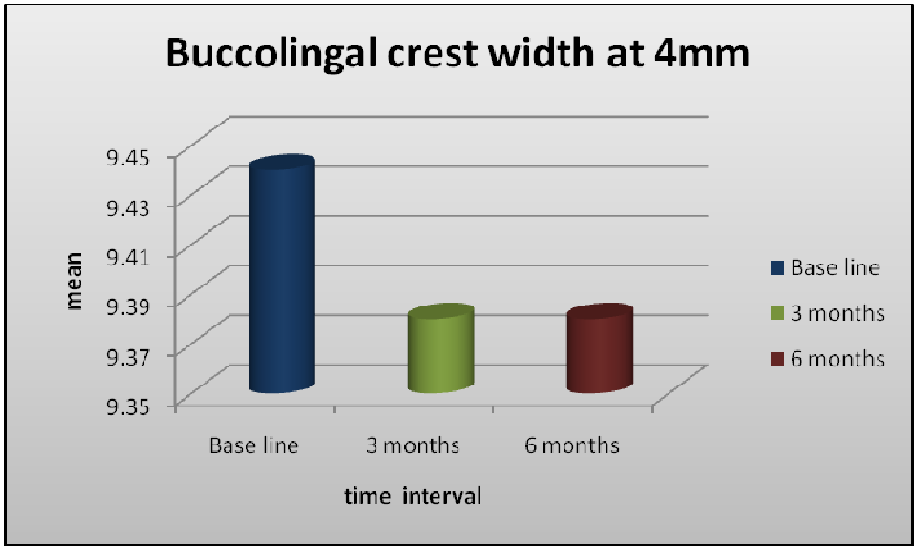
GRAPH #5

COMPARISON OF THE MEAN BUCCOLINGUAL CREST WIDTH AT 2MM-MESIOBUCCAL, MIDBUCCAL & DISTOBUCCAL (mm) AT DIFFERENT TIME INTERVALS



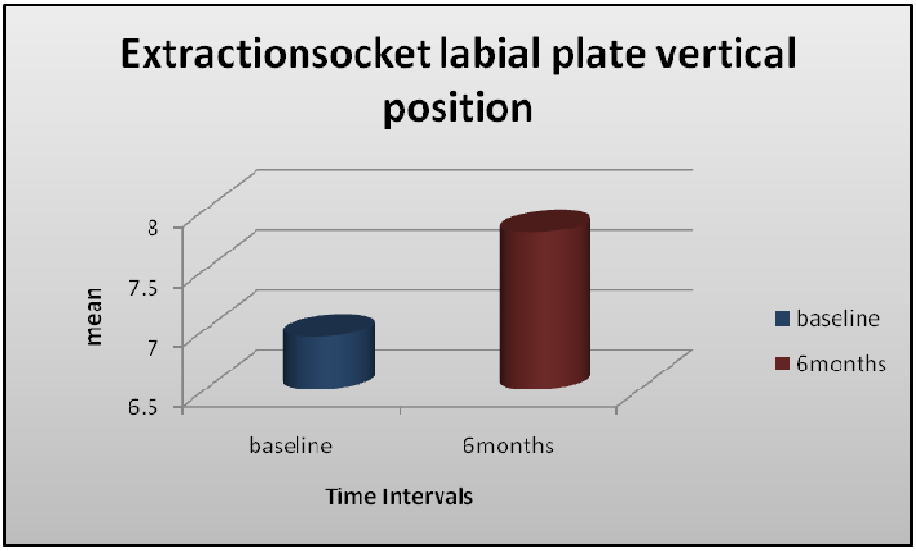
GRAPH #6

COMPARISON OF THE MEAN BUCCOLINGUAL CREST WIDTH AT 4MM- MID BUCCAL (mm) AT DIFFERENT TIME INTERVALS



GRAPH #7

COMPARISON OF THE MEAN EXTRACTION SOCKET LABIAL PLATE VERTICAL POSITION (mm) AT DIFFERENT TIME INTERVALS



DISCUSSION

To achieve endosseous implant positioning that is prosthetically guided with the correct crown-to-root ratio and esthetically maintainable with good soft tissue support, an adequate width of the surgical site is essential. Unfortunately, the spontaneous natural healing process at an extraction wound leads to bone remodelling and resorption. This is more so in cases where the buccal plate is traumatised. The placement of bone replacement grafts into extraction sockets in order to maximise bone formation so as to maintain them for future endosseous implant placement have been advocated.

Clinical and histological investigations in animals and humans have clearly demonstrated that resorption of the alveolar process following tooth extraction is significantly greater at the buccal aspect than at the lingual aspect of both the maxilla and mandible. This study investigated the role of a bone substitute material (Bio-Oss®Collagen) in preserving the ridge following the extraction of ten maxillary single rooted teeth.

Clinical hard tissue measurements using a surgical bone calliper were obtained on the day of extraction (baseline) and after 3 months and 6month healing period.

The results of the horizontal width dimensions at 2mm from the crest showed significant reduction at the third month and the results were

maintained till the sixth month evaluation period. The reduction was observed to be more in the midbuccal region of the alveolar ridge (6.25mm±1.39).

The horizontal width dimension at 4mm from the crest did not show any significant reduction in the buccolingual volume when compared to baseline values (9.75mm ±1.28). These results were comparable to the results obtained by **Nevins et al** [67] where the Bio-Oss® treated sockets experienced a reduction of more than 20% in fresh extraction sockets. The results are also in agreement with the findings presented by **Araujo** [6] that Bio-Oss® Collagen in fresh extraction sockets failed to prevent the minimal marginal ridge contraction of the buccal crest.

The extraction socket was assessed for the number of walls present and the extend of resorption of the individual walls. Multiple animal studies showed that defects of the original buccal plate do not heal completely without use of grafting techniques.[49,73,83] Other studies have also shown that extraction sockets with completely intact bony walls are capable of socket defect bone regeneration on their own.[4,25,72]

The extraction socket labial plate vertical position values measured diagonally from the CEJ of the adjacent teeth to the midpoint of the buccal crest also showed a slight increase in the value 6 months postoperatively(7.81mm ±0.53) the increase in the value is suggestive of the reduction in the crestal buccolingual volume.

In the present study no further reduction of the horizontal crest width at 6 month evaluation was observed compared to the third month values. These findings were in agreement with a study by **Nemcovsky**[66] were he reported that ridge dimensions were slightly decreased during followup. Most of the shrinkage was recorded during the third postoperative month. No change in ridge dimensions was observed subsequently.

The clinical parameter of the distance between the CEJ of the adjacent teeth to the gingival margin (ie the measurement of the gingival scallop) showed statistically significant difference on the buccal side during the third month evaluation (7.31mm ±0.65), whereas no significant reduction was observed in the palatal aspect (5.63 mm±0.52). As documented earlier in literature, the significant loss of tissue contour takes place during the first month following tooth extraction [57,79,60]**.** The change in values during the healing period observed in the present study is suggestive of a flattening of the gingival architecture following tooth extraction. **Fickle S** [37] reported that when the buccal bone plate is resorbed, the soft tissue complex can no longer be stabilized and will collapse into the newly formed space.

The results from the present study relating to the distance from the tip of the papilla to the proximal CEJ of the adjacent teeth showed significant reduction on the buccal aspect (0.81mm±0.7) compared to the palatal aspect (0.75mm±0.38). **Tarnow et al** [86] reported that loss of the interdental bone may

lead to the reduction in the papillary height, as is evident that the soft tissue contour always conforms to the underlying hard tissue topography.

The width of keratinised gingiva was significantly reduced in the postoperative evaluation periods (2.88mm±0.35).Whether primary wound closure should be achieved after socket grafting is a matter of fundamental disagreement between clinicians, as soft tissue coverage of the extraction socket is often difficult to achieve as a result of the soft tissue opening left by the extracted tooth. **Yukna et al** [91] reported that a pedicle flap and/or submucosal dissection developed to extend the soft tissue to cover the socket area, often causes a reduction in the vestibular depth, and thereby creating a mucogingival defect. Some clinicians advocate a tension free closure of the socket with a gingival graft especially in the anterior region. [53] **Landsberg and Bichacho** [58] stated that due to primary wound closure and the additional mechanical stability of the free gingival autografts, the soft tissue collapse might be avoided to a certain extent.

Gingival thickness was assessed at baseline, 3months and 6 months with no significant variation in measurements observed (1.44mm ±0.18). **Pietrokovski** [75] reported that in the horizontal plane, bone loss occurred largely at the expense of the facial cortical plate, increasing the risk for facial soft tissue recession, especially in the presence of a thin periodontal biotype. In this a gingival thickness of moderate biotype (1-1.5mm)[55] was observed.

One of the reasons for placing a graft is to provide a scaffold for new bone formation. This objective was met in the current study. Histological evaluation post 6 months of the augmented site revealed larger amounts of new bone formation, confirming to the osteoconductive property of Bio-Oss® Collagen. Histological analysis of 5 of the 8 samples exhibited only residual particles of the bone graft present. The formation of vital bone was appreciated. These results were in accordance with the histomorphometric analysis by **Araujo et al** [6] on extraction sockets augmented with Bio-Oss. The graft particles were surrounded by newly formed bone which suggested that during continued healing, these biomaterial particles may become integrated with and further enhance hard tissue formation. Bio-Oss® has been reported to act as a scaffold for de novo bone formation. In most respects, the current histological findings are in accordance with observations made in clinical and experimental studies showing that an intimate contact frequently is established between pure Bio-Oss® particles and newly formed mineralised bone. [89,23] **Cardaropoli** [30] reported that in the grafted site with Bio-Oss® Collagen, total relative volume of newly formed mineralised bone amounted to 46.7%.

In 2 of the grafted extraction sites, de novo bone formation appeared limited. A multitude of Bio-Oss particles were present in a dense connective tissue matrix. The reason why occasionally these biomaterials failed to promote hard tissue formation is not fully understood. It has been suggested however that in such cases, coagulum formation following root extraction may

have been compromised or the wound may have been contaminated and the coagulum degraded early, thus jeopardizing new bone formation.[6] **Becker [19]** reported the presence of Bio-Oss particles present after 3 to 7 months. Retention of such bone chips may interfere with normal bone formation, may take several years to be replaced and may weaken the bone at the grafted site.

In one of the 8 subjects who presented clinically with an avulsed tooth preoperatively, encapsulation of the graft material was observed radiographically at 6 months postoperatively. A similar case of fibrous graft material encapsulation was reported by **Becker [19],** who concluded that this may influence the bone-implant interface following osseointegration. Another study also reported fibrous encapsulation of Bio-Oss®Collagen and limited histological evidence of bone formation.**[70]**

Clinically, granulomatous tissue formation was observed in one of the grafted site 3 days postoperatively. Radiographic examination of the site revealed the partial absence of graft material. Contamination of the extraction socket may be one of the reasons for this observation.

Radiographic assessment and histological analysis of the 8 augmented site specimens presented residual graft particles along with vital bone. This observation was in accordance with data previously published from studies in human and animal models **[20,32,71,74]** which shows that the elimination of Bio-Oss is a slow process that may require a long time. It is believed that the

xenograft is eventually replaced with host bone during the process of remodelling[5].Data presented by **Wetzel et al,[89] Diez et al [34]** indicates that during healing, Bio-Oss may occupy an area that would otherwise house the bone marrow. Provided this assumption is correct, an extended period of healing may be required to determine i) the ultimate fate of the biomaterial ii) whether the continued remodelling may alter the dimension and profile of the edentulous ridge.

One purpose of placing a bone substitute n a self contained hard tissue defect is to offer stability for the coagulum and hence avoid volume reductions and surface invaginations that otherwise would occur when the wound contracts.[30] In the current study, these objectives were to a major extend satisfied. In contrast, **Becker [20]** questioned the use of grafting materials in fresh extraction sockets citing the possibility of interference with the normal healing process.

Within the limitations of this study's small sample size, the results of the present investigation promote the use of a bone substitute to fill the post extraction site, so as to maintain the alveolar ridge profile and simultaneously prevent alveolar bone loss, thus making it more suitable for endosseous implant placement. A larger patient population incorporating a comparative evaluation against a control group and a long term evaluation coupled with stringent measures for histologic analysis would surely lend more credibility to this study.

SUMMARY AND CONCLUSION

The present study involved a clinical and histological evaluation of extraction socket augmentation with deproteinised bovine bone mineral xenograft with porcine collagen matrix (Bio-Oss®Collagen block). The study population comprised of 10 patients (4 females & 6 males) with age ranging from 25-55 yrs. Among the 10 patients included in the study, one patient is still under 6months postoperative evaluation period. All patients returned for scheduled maintenance visits. Post operative healing in the grafted areas was satisfactory except one patient reported with granulomatous tissue within the grafted site. Another patient presented with graft encapsulation on radiographic assessment.

The following clinical parameters namely width of keratinized gingiva, soft and hard tissue dimensions assessed at baseline 3months and 6 months revealed statistics favouring the use of Bio-Oss®Collagen as a bone replacement graft. In addition histological evaluation of biopsy specimen, during re-entry surgery during implant placement from the augmented site was conducted.

Within the framework of this study, the following conclusions have been elucidated:-

1. The difference in values of clinical measurements of the mean width of keratinized gingival, buccolingual crest width and extraction socket labial plate vertical position were suggestive of a reduction in the horizontal alveolar bone volume. The corresponding measurements on the palatal aspect showed no significant change from baseline values.
2. Histological analysis revealed new bone formation along with minimal residual graft material; indicative of ongoing bone remodelling.

The results presented here clearly demonstrate that cancellous-bone block xenograft (Bio-Oss® Collagen) used as a bone replacement graft in extraction socket preservation procedure yielded favourable clinical results for appropriate implant placement. However, it is necessary to have a large sample size and long term controlled clinical trials to evaluate the true efficacy of this material.

Future developments in socket preservation should incorporate bone augmentation techniques involving custom shaped bone substitute, thus greatly simplifying the surgical protocol. Newer materials in the fray should contain a matrix endowed with cell in-growth capacity, which would influence biologic principles of the material, thus enhancing its regenerative potential and function similar to natural bone.

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